The Builder.

VOL. XXXVI. No. 1845. SATURDAY, JUNE 15, 1878.

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GENERAL CONFERENCE OF ARCHITECTS, 1878.

IN resuming our notes* of this Conference, which was brought to a close on Friday evening in last week, we may, in passing, congratulate all concerned on its success. Especial mention should be made of the fact that its success was largely due to the exertions of the honorary secretaries to the Conference Committee,—Messrs. Arthur Cates and R. Phené Spiers, — who, in conjunction with the Secretary of the Institute, Mr. W. H. White, had made the most satisfactory arrangements for the convenience of members of the Conference, and for facilitating the work of those who have had the arduous task of chronicling its proceedings. The visits to the New Law Courts, and to the New Natural History Museum, which will be described hereafter, were fraught with many practical lessons. This was especially the case with Mr. Waterhouse's new museum at South Kensington, inasmuch as that building exemplifies, on a scale unprecedented in this country, the capabilities of terra-cotta as a constructive and decorative material. The visit to Mr. Kirkaldy's Testing and Experimenting Works in Southwark-street (the advantages offered by which are perhaps not so fully appreciated and made available as they deserve to be) was equally interesting. Of the visit to St. Paul's Cathedral we gave some notes last week†. The visits to Dorchester House, Bridgwater House, and Grosvenor House afforded opportunities for seeing some famous works of art not always accessible. The Conference meetings proper, though not in any instance very largely attended, were nevertheless very successful, for in each case the able papers read elicited good, practical discussions, the speeches being, as a rule, brief and to the point.

THE CORROSION OF IRON.

As mentioned in our report last week, at the Conference meeting on the evening of Wednesday, the 5th inst., Professor T. Hayter Lewis occupied the chair, and Professor Barff read a long and interesting paper on his process for preventing the corrosion of iron, of which we now give some portions.

* See pp. 579-586, *ante*.
† See p. 582, *ante*.

The Chairman, in introducing the lecturer, said Professor Barff was well known to most of the audience as a gentleman of great scientific attainments. In addition to that recommendation, he had extra claims upon them as artists, inasmuch as he held the important position at the Royal Academy of professor of chemistry,—the adviser of our painters, in fact, on all questions as to the use of colours and pigments. In that capacity he had doubtless conferred great benefit upon painters, and on the world of art in general.

Professor Barff then read his paper. He said:

The process which I am now about to explain does not consist in coating the surface of the iron with any applied substance, but in changing the iron itself by the addition of oxygen into an oxide which is not affected by atmospheric influences. The agent employed is superheated or dry steam. I am frequently asked how steam which is generated from water, which is wet, can be made dry. The three substances, water, ice, and steam, are all chemically the same; they are of the same composition, and are formed by the union of 16 parts by weight of oxygen, and two parts by weight of hydrogen. These gases when set free by the decomposition of either of these substances occupy certain measures or volumes; the 16 parts by weight of oxygen occupy one measure or volume, and the two parts of hydrogen occupy two volumes, each exactly the same as the volume of oxygen. If two measures of hydrogen and one of oxygen be put together, and be caused to unite, they will form water; if this water be formed at the temperature of 212° Fah., or 100° C., the volume of the steam formed will be the same as that of the hydrogen. When ice is heated it does not get warmer if it is at the temperature of 32° Fah. or Zero C., but it melts, and when melted is water at the same temperature; also when water is heated to 212° Fah. it gets no hotter however much it be heated, if the vessel which contains it is open to the air, but the additional heat converts it into steam at 212° Fah. Now this steam being generated in contact with water, takes up water in suspension along with it, and is called saturated steam. If, however, a quantity of this saturated steam be heated by itself, and be allowed to expand, the water which is held in suspension is also converted into steam, so that if the presence of water be necessary to constitute wetness its absence will constitute dryness, and the steam in the first case —*i.e.*, the saturated steam—will be called wet; and that in the second will be called dry. Now this dry steam can be heated to any temperature. Steam in the dry state is a colourless transparent gas, and when heated it expands at the same rate as other gases or nearly so. Steam is invisible; no one has ever seen steam. What we see and call steam is not steam, but condensed water vapour in a state of very fine division. All gases when they come in contact with water take it up and hold it in suspension. The warmer the gas the more water it will take up. This is easily seen in a hothouse or a washhouse; the air becomes highly charged with moisture, and this moisture is deposited as water on the cold windows, proving that as the air is cooled it holds less moisture in suspension; but at no time is the moisture visible in the air until it condenses. In operating upon iron with steam for forming the protecting coat the steam must be dry, *i.e.*, it must hold no water-vapour in suspension; for, if it do, another oxide of iron is formed as well, which is what is called red rust. There are certain metals which decompose water, some at the ordinary temperature of the air, others at high temperatures, and some metals do not decompose water at all. The way in which they decompose water is by taking from it its oxygen, and setting free its hydrogen. Potassium and sodium, and some other metals, decompose water at the ordinary temperature of the air, and these metals, uniting with the oxygen of the water, form what are called oxides, and hydrogen is set free. Thus potassium forms its oxide potash, and sodium soda. In these cases, however, some of the hydrogen,—that is, one half, remains with the oxide, forming a hydrate; but I need not here do more than mention this. Iron decomposes water or steam at a high temperature, *i.e.*, at a red heat; all the oxygen of the steam unites with the iron, and all the hydrogen is set free. If the steam be in the saturated state when the iron is submitted to its action, I discovered that the oxide formed does not adhere firmly to the iron; but if the steam be superheated or dry, the oxide does adhere very closely to the iron. In this case it seems that the moist steam first forms the red oxide of iron, and this is reduced—by the hydrogen set free—to the metallic state, and it is in a state of fine division; and this finely-divided iron is then, by fresh steam, converted into the black oxide. Having passed through these changes, it will manifestly have lost its bond, and although it adheres for a short time, it is before long thrown off; rusting is then set up on the surface which it covered. All chemical actions take place in definite quantities. Iron unites with oxygen in several different proportions; for example, 56 parts of iron unite with 16 parts by weight of oxygen, and what is called protoxide of iron, a ferrous oxide, is formed. Now this oxide is very unstable. In the presence of oxygen and moisture it is very rapidly changed into another oxide, twice 56 parts by weight of iron and 16 of oxygen, *i.e.*, ferrous oxide unites with the same weight of ferrous oxide, so that 2 (56) of iron and 2 (16) of oxygen together unite with or take up another 16 parts by weight of oxygen, forming another oxide called peroxide of iron, or ferric oxide, and this is the substance known as iron rust. It seems clear that the first action of oxygen on iron is to form the ferrous oxide, and this, as I have explained, gets converted rapidly into ferric oxide. Now, imagine the surface of a piece of iron in moist air to be thus coated, it will not be difficult to understand that the entire oxygen which this ferrous oxide takes up to become ferric oxide is passed on to the iron beneath it, forming with it ferrous oxide; and that the first ferrous oxide formed takes up more oxygen, and becomes ferric oxide again. This process goes on continuously till all the iron is in time converted into ferric oxide. The ferrous oxide then acts as a carrier of oxygen to the iron, causing it to be changed throughout its mass into oxide. Now, this action does not take place with other metals which are used in building, because these metals do not form the oxides in the same way in which iron does. Take lead for example: it only forms one oxide by the direct action of oxygen upon it; and, when its surface is covered with oxide, no further change takes place, except that the oxide becomes converted into carbonate by the carbonic acid gas in the air. The whole of the

metal which is changed from the metallic state is changed in a short time, so that no further action goes on unless the coat formed be removed mechanically: hence it gives for ages protection to the lead beneath it. A similar action takes place with zinc, and also with copper. All these metals are known to last well when exposed to air, if they be not attached to the place where they are applied by other metals which with them cause galvanic action. Besides the two oxides of iron which I have mentioned, there are others, one only of which will need our attention; it is called the magnetic or black oxide. It is supposed that this oxide is made up of the other two, viz., the protoxide and the peroxide; for, if we add together the weights of these oxides, we shall have three (56) parts by weight of iron, and four (16) of oxygen; and this is the proportion in which these elements unite together to form this black oxide.

Many experiments which I have performed tend to confirm this view of the constitution of magnetic oxide of iron, but I need not trouble you with a relation of them, as they are of more interest to chemists than they possibly can be to you; and they in no way bear on the industrial application of magnetic oxide to the arts. A piece of perfectly dry clean iron will not oxidise in dry air. Moisture is necessary to cause the oxygen of the air to unite with it; and whenever iron is exposed to moisture ferric or red oxide of iron is the result. But when iron is burned in *dry* air or oxygen, this red oxide is not formed; the black oxide is produced. If, however, an experiment be carelessly performed to illustrate this, if the air or oxygen be not *dry*, then some red oxide will be formed along with the black. The black magnetic oxide of iron is not affected by oxygen in the presence of moisture, and thus it affords a protection to the iron upon which it is formed. Long before I brought my process to its present state, I felt that if I could make this oxide adhere firmly to iron, it would resist the ordinary rusty action; and when I showed my first specimens to scientific and practical men they expressed their opinion that the principle was correct. They felt sure that whatever difficulties might be encountered, they could be overcome. And the difficulties have been great, for it has taken more than two years to bring the process into such a state that commercial men could regard it as of practical utility. When I read my paper before the Society of Arts, on the 14th of February, 1877,* Admiral Selwyn said, in the discussion which followed, that "in New Zealand you could find any quantity of this substance which had remained totally unchanged, even by the action of salt water, during all the centuries which had elapsed since the creation of the world." Nor have I ever met with any one who knows anything about the subject who has the slightest doubt as to the enduring properties of the black oxide of iron. The only doubt I have ever heard expressed is whether this substrnce can be artificially formed so that its own particles will stick together and adhere firmly enough to the iron on which they are produced. I believe now that there is no doubt on this point, for many have proved it to be so hard that it will wear away a rasp before it can be removed from an iron surface.

I will now proceed to explain *how* the process is conducted. At first I used to allow water to pour down a pipe from a height of about 34 ft., into a coil consisting of some 80 ft. of iron pipe of about ⅜ in. bore. This pipe was contained in an iron cylinder, so arranged that a fire might be lighted in its centre, the flames of which could surround the pipe in order to make it red-hot through its entire length. The water was held back by a tap, and when the pipe was hot enough it was allowed to run into it,—the water entering at the lower end of the coil. The water which first reached the red-hot pipe was converted into steam; this was driven on by that behind it; and so the steam, passing through the red-hot coil, became superheated as long as the coil was kept hot enough. The water was kept back by the force of the steam, so that it only entered a short distance; the steam thus generated and superheated was then conveyed into an ordinary glass-painter's muffle, entering at the back. This muffle, to prevent the condensation of the steam, and to raise the articles to be heated to a sufficiently high temperature, was heated by a fire in the ordinary way. After the muffle was charged, sufficient time was allowed for heating its contents; then the door was closed and luted with fire-clay, and the superheated steam was turned on. From four to six hours was the time to which the small articles then treated were exposed to the action of the superheated steam. These smaller specimens before you were exposed for about this time. Certain difficulties arose from this method of generating the steam. I need not tell you what they were, as I have now quite abandoned it. I may, however, mention one,—and that was, the liability of cooling the coil when the fire had to receive fresh coal. In this case the steam got wet, and red oxide was formed which, as I have already explained, interferes with the durability of the coating. To prevent this, too, much care and constant watchfulness were required to render the process commercially successful. The apparatus I now employ consists (first) of an ordinary boiler, in which steam is generated, usually at a pressure of 40 lb. to the inch. My boiler is a very strong one, as it is adapted to other experiments; one which is safe at 40 lb. pressure is sufficiently strong for this work. From the boiler the steam passes into a tight iron box, where it parts with some of its moisture, for the steam is saturated; from this box it passes into the superheater at its original pressure. The superheater consists of two stacks of pipes placed in a furnace parallel to one another, with a space of about 15 in. between them. These stacks are supported on dwarf walls of fire-brick, and are connected together so that the steam traverses the whole length of all the pipes, which is about 36 ft. The pipes are 1½ in. bore, and are kept at a red heat, or even at a higher temperature. The steam in its passage through them becomes superheated, and when it issues from the end it would set fire to the wood. The end of the superheater-pipe is connected with the back of a chamber built of fire-bricks. This chamber is 5 ft. long, 2 ft. 6 in. wide, and 1 ft. 6 in. high, arched at the top. Beneath it is a fireplace, and up its sides flues pass, so as to insure it being uniformly heated. It is closed with an iron door, faced with fire-tiles, 1¼ in. thick, which is easily raised by a balance-weight. When it is closed, to work the process, the fire is lighted beneath the chamber, and it is heated to a temperature of about 700 deg. or 800 deg. Fahr. All this time the superheater is being raised to a proper temperature,—that is, to a cherry-red heat, and the steam is got up to 40 lb. in the boiler. The chamber is then opened, the iron articles are placed in it, and kept there until the temperature rises again to from 700 deg. to 800 deg. Fahr. The door is then luted with fire-clay, and the steam is then let in gently,—not with the full force that it has at a pressure of 40 lb. The great object is to keep the chamber full of steam during the operation, and to effect this a slight, but very slight, pressure is kept up. This is effected by ⅛-in. pipe placed at the upper part of the front of the chamber, close to the door. The pipe rises for about 2 ft. 6 in. vertically, and then bends down to beneath the fireplace of the superheater, where it discharges excess of steam and the hydrogen evolved in the operation. At the top of this exit-pipe, before it begins to bend, a valve is placed, suitably weighted, to prevent undue pressure in the chamber.

In the discussion which followed,

Mr. J. T. Wood said the lucid manner in which the Professor had explained his valuable discovery and its application left him (Mr. Wood) very little to say, were he ever so scientific, which he did not pretend to be in the least. Of course the invention would be of the greatest advantage to architecture. Amongst small matters, for example, he might instance the screws which the carpenter invariably put into his mouth and wetted with his spittle, so as to make them more easily driven home. They afterwards rusted in the wood. Screws treated by Mr. Barff's process, however, would take no harm under such circumstances. Everything in iron that the architect could design or specify, in fact, whether constructive or ornamental, could be advantageously treated by the process. Knockers, latches, and small articles of that kind, instead of requiring to be painted, would have the beautiful blue-black lustre imparted to the iron by the process. Professor Barff had told him (the speaker) of his invention a year ago, and at that time he heard that Professor Barff had been offered a vast sum for the patent, but he would not part with it, and the public were indebted to him for not doing so, as he was the more interested in perfecting his discovery and rendering it practically available for various uses in engineering and architecture. Every one present would hope that the process would be as commercially successful as it appeared to be technically satisfactory. He begged to move a vote of thanks to the Professor for so kindly coming forward and giving so lucid a description of his important discovery.

Mr. Carroll, in seconding the vote of thanks, said, that coming, as he did, from unpractical romantic Dublin, to practical unromantic London, he felt surprised that a paper of such surpassing interest should not have drawn a larger audience. Probably the thinness of the meeting was due to the fact that it clashed with the doings at Epsom. He suggested that, in future, the Conference should be so arranged as not to fall in the "Derby" week.

The Chairman explained that the Conference committee had been misled by the almanacks, all * of which had put down the Derby to be run on its usual day, viz., the last Wednesday in May, instead of the first Wednesday in June.

Mr. Carroll said that, as showing the necessity for the adoption of some such process as Professor Barff's, he might mention that, in order to attend the Conference, he came through the Britannia tubular bridge over the Menai Straits, and was greatly shocked to see the way in which that structure was rusting away. He was travelling with an engineer who had had something to do with the erection of the bridge, who remarked that he never felt so near eternity as when coming through the tube. There was no doubt a process of rusting going on which must eventually, unless checked, have the effect of making the bridge come down with a crash. He believed that tons upon tons of rust were extracted from the tube every month. It would be very interesting to know whether Professor Barff's process could be in any way applied to such structures as that *in situ*. For small articles, or for the component parts of bridges and similar structures before being built up, the process, if found to be permanently successful, would be of undoubted value. He should like to know what was the actual cost of the process as a percentage added to the cost of paint and other would-be preservative coatings.

Mr. Reed said he understood Professor Barff to say that in treating bolts by his process there was an appreciable increase in their diameter, and this, as it seemed to him, would militate against the usefulness of the process as applied to the ironwork of roofs, &c.; for the thread on the bolt would be increased, and the thread in the nut would be made of less diameter, thus preventing the parts being fitted together. He should also like to know whether it was possible to treat by the process large pieces of roof, such as T-iron rafters, say 60 ft. long?

Mr. Kershaw, C.E., said that Professor Barff had mentioned 40 lb. as the pressure of steam at which he had conducted his experiments. Was it not possible to attain the end in view with less pressure of steam, and, if so, with how much less? He (Mr. Kershaw) took it that the steam was merely the medium of conveying the heat, the pressure being immaterial. He asked this question, because it involved a point which would materially affect the cost of using the process. He took it that the treatment of large structures, such as the Britannia tube, *in situ*, would be impossible, for it would involve the construction of boilers or containers large enough to contain the objects to be treated.

Mr. Dawson remarked that it was unnecessary to speak of the importance of the subject, which was one of the utmost practical value and importance. He thought that the Professor's paper would be productive of great good. He gathered from it that the protective coating of black oxide was imparted to the iron articles treated by means of superheated steam, and that the thickness of the coating was about the thousandth part of an inch.

Professor Barff said the thickness of [the coating varied with the duration of the process. For most small articles that would be about the thickness.

Mr. Dawson, continuing, said he should like to know which would be most benefited by the process (if there was any difference) ordinarily,—thoroughly good cast iron, or thoroughly good wrought iron,—because it was always found in practice that wrought iron rusted much sooner than cast iron. With regard to treating such

* See *Builder*, vol. xxxv. (1877), pp. 160-162.

* Not so; that useful compendium, "Whitaker's Almanac," allots to the event its correct date.

structures as the Britannia tube *in situ*, he apprehended that the sole but insuperable difficulty was the provision of a chamber sufficiently large to contain the article to be treated. But of course the treatment of such structures *en masse* was impossible. On the other hand, he took it that the whole of any built-up structure of iron could be treated by the process before erection, provided that a container could be made large enough to take in the largest single pieces of the structure,—which, he supposed, it would not be difficult to do. But then, how about the rivets? If they were treated by the process before hand, would not the making them red-hot and hammering them destroy the preservative coating which had been applied to them? Probably in the case of bolts and nuts, the screwing-up by a spanner would not destroy the surface of black oxide. As to the advantages of the process if brought to perfection and generally adopted,—especially if the cost were not very great,—it would be waste of words to dilate upon them, for it would be one of the most magnificent inventions of the age. The Professor had mentioned the lamp-pendant which had been treated by his process, and fixed up in one of the western lobbies at St. Paul's Cathedral. On the occasion of the visit made on the previous day to the cathedral, Mr. Penrose had directed attention to the pendant, which had, he understood, been in its present position for the past ten months. From his (the speaker's) careful observations, it was only right that he should mention that in certain parts the pendant *did* show signs of rusting, such rust appearing in the form of small rings, all of which, as far as he could observe, were opposite where the welding had been effected. These rings were all of red rust, but there was no indication of spottiness or "pock-marks," showing, as he gathered, that the red rust did not get under the black oxide.

Mr. Burden said that if the process could be applied without materially enhancing the cost of the articles treated, it would be of incalculable benefit for architectural purposes.

Mr. Nevill said he should like to know whether hammering upon the surface of the metal would have the effect of destroying the protective coating of black oxide. This was a point of great importance, for any preservative process for ironwork ought to be capable of standing a fair amount of wear and tear. It was satisfactory to hear that the surface was not affected by ammonia.

Mr. Skidmore, of Coventry, said that if Professor Barff's process were only applicable to iron articles of minor size, it would be of incalculable value, whatever might be its possibilities of application to such structures as the Menai Bridge. With regard to that bridge, he could testify to the enormous quantity of rust which it yielded, the man engaged in clearing it away being a veritable red man. As a worker in iron himself, he should gladly welcome any process which would preserve ironwork from its insidious but ruthless destroyer—red rust.

Mr. T. H. Watson asked whether any special preparation of the metal was necessary before submitting it to Professor Barff's process? He asked this question because all the objects exhibited presented a certain cleanness and finish of surface and texture which it was not customary to see except in specimens of cast-iron work made from very carefully-prepared patterns. From something that dropped from the Professor as to the effect of the process upon very small articles, it occurred to him (the speaker) that the finish was partially, if not wholly, due to the process itself. Were the articles subjected to any treatment after the process, in order to secure a satisfactory finish of surface? Anyhow, from an artistic point of view, it was quite unnecessary to stipulate that the cost of the process should be small. The attainment of such a finish in ironwork at once elevated the metal almost to the level of bronze and the costlier metals for the purposes of art. Many of the objects exhibited were equal in surface texture to copper or bronze. As to colour, it was very pleasing, for it was not absolutely black, having a dark bluish-grey tinge, utterly unlike that of the Berlin black used by stove-makers. At the same time, the material could not be mistaken for any other than iron. He should like to know whether Professor Barff could tell the meeting the effect of age upon iron treated by his process? Would it "age" in anything like the same way as bronze or copper?

Mr. Bailey said he should be glad to know whether the expansion and contraction of the metal would crack or otherwise affect the preservative coating.

Mr. Arthur Cates said that even omitting all consideration of such large structures as bridges, the importance of preserving which from decay was exceedingly great, the application of such a process as Professor Barff's to architectural ironwork,—much of which would otherwise, if left exposed, speedily decay,—was, as had been said, of incalculable value. It was pitiable to see the way in which beautiful ironwork was perishing away through the formation, by the action of the atmosphere, of the red ferrous oxide. Coating with paint, even if it were always effectual, when repeated over and over again completely destroyed the charm of the smith's handiwork. Professor Barff's process, however, had the great merit of not only not injuring the surface, but of heightening its beauty. When it was remembered that a great deal of beautiful ironwork had utterly disappeared owing to the action of rust, it would be agreed that it was impossible to overrate the importance of Professor Barff's process, provided that it fulfilled the expectations which had been formed of it. Professor Barff had not referred to the domestic applications of the process, as exemplified in the saucepan exhibited, and which, though it had been in constant use for some months, showed no perceptible signs of wear, nor was it furred or coated in the interior, as tinned or enamelled saucepans were apt to become. The only objection against the saucepan, and that was a fanciful one, was the blackness of its interior. Another very important application of the process would be the protection of iron pipes used for the conveyance of water. There had been many attempts to produce conduits which would not be affected by the chemical agents suspended in the water. There had been tin-lined lead pipes; glass or glass-lined pipes had been proposed and tried; enamelled iron, galvanised iron, and all kinds of materials had been used, some of them with partial success; but Professor Barff's process seemed to be the nearest approach to perfection that had yet been attained in that direction. As several of the pipes could be stacked in the vessel or container for subjection to the process, iron pipes so protected would not be appreciably dearer than those not so protected, while they would be much cheaper than and immeasurably superior to lead. In this way the many disadvantages and inconveniences attending the at present almost indispensable use of lead pipes would be avoided. With reference to the hardness of the coat of black oxide deposited on the iron by the process, he had before the meeting made some inquiries of Professor Barff on the subject, from whom he learnt that the coating resisted the action of a file upon the surface, the only perceptible effect of filing being that the file itself became burnished, no effect being observable upon the specimen filed. That was a very important point. The resistance of the coating of oxide to a shock or impact was a point which Professor Barff had not touched upon. It would also be desirable to know something of the manner in which iron thus prepared resisted the action of considerable heat.

The Chairman, in putting the vote of thanks to the meeting, said it seemed to be the general opinion that, if Professor Barff's invention were successful,—as they all hoped it would be, and as the Professor himself, as a chemist, believed it would be,—it would be one of the finest inventions, so far as architects and engineers were concerned, that had ever been brought forward. When it was recollected that enormous treasures of art in iron had been lost through the action of ferric oxide, or red rust, the importance of the process, even from an antiquarian point of view, would be seen. There were in the British Museum a few,—a very few,—specimens of Assyrian ironwork which had been preserved almost by a miracle. These would give some idea of the enormous amount of artistic wealth that must have been lost through the action of red rust. Reference had been made to the slow but sure destruction going on by the rusting of the ironwork of the Menai Bridge; the same destructive process was to be seen at any of our metropolitan railway stations and bridges. He had recently seen whole courses of stonework, in buildings by Sir Chistopher Wren and his pupils, almost totally destroyed by the rusting and expansion of the iron cramps with which the work had been tied together. If iron could be so treated by the Professor's process as to permit of its being safely used for cramps, it would in itself be of very great advantage, for at present it was necessary to use bronze, copper, or slate,—the latter being by no means a satisfactory material for cramps, and the others being too costly. Galvanised iron, though introduced to the world some years ago with a great flourish of trumpets, and at that time considered to be perfectly imperishable, had not been a success, for the rust was found to go on behind the coating of zinc. The question arose whether Professor Barff's process would come to grief in any similar manner? He (the speaker) from what he had heard of it, and from what was stated by Admiral Selwyn when Professor Barff read his paper before the Society of Arts, did not think this would be the case.

The vote of thanks having been carried by acclamation,

Professor Barff replied to some of the questions raised during the discussion. In answer to Mr. Carroll he said his process could not be applied to structures *in situ*, because every article to be treated must be raised to a temperature above red heat. He could not give any exact idea as to cost, but he might state that a superheater 5 ft. long by 2 ft. 6 in. by 1 ft. 8 in., which would hold a great many moderate-sized articles, would cost about 5s. for fuel during ten hours' working. That was his own experience, although it could, probably, be done for less, for he did not pretend to be studying the economical aspect of the process. His sole object at present was to do the thing well, leaving the question of economy to take care of itself. The process could, of course, be most profitably worked continuously, night and day, with relays of men. This method of work was being pursued by Messrs. Spencer, of West Bromwich, who were working his process under a royalty. The cost under such circumstances would certainly be nothing at all approaching to that of galvanising. In answer to Mr. Reed's question, it was necessary to make bolts or nuts which were to be treated by his process of such dimensions as to thread and nut that, although before being subjected to the process, they would not fit, yet after treatment they would fit. This could be done with the greatest nicety. As to treating pieces of roof 60 ft. long, they would require an enormous chamber. Then, as to the questions of hammering and riveting: when rivets which had been treated by the process were heated or hammered, or pressed in by the riveting machine, the coating of black oxide was undoubtedly removed. This was, he confessed, a difficulty, but one which he thought he should succeed in surmounting. He was now trying experiments with an apparatus for re-oxidising the heads of the rivets *in situ*,—although, for that matter, even though he were unsuccessful, he did not think it would be of very great moment, for only the head of the rivet would be exposed, and it would not be possible for a rivet to rust right through. In answer to Mr. Kershaw's question, the extreme pressure of steam used in working was 40 lb., but sometimes it would not exceed 25 lb. But one point of the greatest importance was that there should always be such a sufficiency of pressure as to exclude the oxygen of the atmosphere. In answer to another speaker, the thickness of the coating of black oxide would vary according to the duration of the exposure of the article to the superheated steam, and according to the bulk of the article treated. In oxidising a thick mass of iron, the pores would become thoroughly closed, and as no more steam could enter, the material operation was at an end. If, on the other hand, thin sheets of iron were treated by the process, they could be oxidised almost right through, leaving only a thin film of good metal in the centre. This rendered the metal very brittle and easily broken, hence the necessity of care in the treatment of thin pieces of metal. Both wrought and cast iron were equally benefited by the process. As to the appearance of the surface of iron treated by his process, it was solely the result of the process, nothing being done to prepare it. He had not seen the pendant at St. Paul's, but Mr. Penrose had told him that it had not rusted. The indications of rust referred to by Mr. Dawson might have been caused by the workman who fixed the pendant abrading the surface of the coating with his pincers or gas-tongs. At any rate, it was satisfactory to hear that the rust, whatever its cause, was localised. As to the question whether the surface of the protective coating was strong

enough to bear hammering, he thought it was; at any rate, it could not be removed unless wilfully. The coating did have a tendency to chip when continuously hammered, but a nail treated by the process could be driven by the hammer without injury. In answer to Mr. Watson, no preparation of the surface was required beyond the removal of red rust (if any existed) by pickling the article in dilute sulphuric acid. Time would not "age" iron treated by his process,—at any rate, not in the sense in which copper and bronze were affected by long exposure. In answer to Mr. Bailey, the expansion or contraction of the metal did not affect the preservative coating in any way. He observed that the Conference was on the following evening to discuss the subject of fire-proof constructions, as to which he might be allowed to say that it would be a very great thing if the ironwork in them were oxidised by his process, as it would then be a very long time before the iron could be burnt away. He believed that in most systems of fireproof construction wet concrete and cement were placed in immediate contact with iron girders, and hence rust must be set up. He could only say, in conclusion, that two years' experience and observation had thoroughly convinced him of the permanence of the results attained by his process.

GENERAL BUILDING REGULATIONS FOR THE UNITED KINGDOM.

At the Conference meeting on Thursday afternoon, the 6th inst., Mr. J. Whichcord presided, and the above was the subject for discussion.

The Chairman, in opening the proceedings, observed that the papers to be read would be of great practical interest, particularly to non-metropolitan members of the profession, although all must be deeply interested in so important a subject. He would not make any prefatory remarks himself, reserving what he had to say until the close of the discussion. He desired, however, in some measure to congratulate the Congress upon the programme that had been prepared. Though that programme contained subjects of extreme practical importance, art questions and matters relating to the *dilettantism* of architecture were by no means absent. The subject to be discussed on that occasion involved matters of imperial interest, inasmuch as it dealt with the laws belonging to buildings over the whole kingdom. If one subject more than another could be selected as appropriate to a general conference of British architects, representing different localities, that subject was the suggestive one of general building laws for the whole of the kingdom.

Mr. J. Douglass Mathews then read his paper on "The Model Bye-Laws as the Basis of a General Building Act." Of this paper we gave the substance last week (pp. 583-584).

A paper by Mr. Joseph Boult, of Liverpool, was then read by Mr. Cates, who stated that Mr. Boult represented the Liverpool Architectural Society. That Society had considered the Model Bye-laws with considerable care, and in November last the council made a report on the subject touching upon many points which were deserving of further discussion.

In his paper Mr. Boult said,—

"Before entering upon the consideration of the model bye-laws as a basis for a National Building Act, it seems desirable to cite a few principles which are embodied in recent legislation, and which therefore may be accepted as axiomatic:—

1. That all trading operations should be subject to as little legislative interference as is consistent with the public welfare.
2. That it is desirable to have in force such regulations as will secure stability in buildings and reduce the risk from fire.
3. That it is also desirable to have in force such regulations as will secure those provisions for drainage, cleanliness, and ventilation which are essential to health.
4. That as the conditions under which buildings are erected vary indefinitely with the purpose, the site, and the materials, the legislative requirements should be as few and as elastic as is consistent with the securities referred to above; and that the imperfections of language should be amended by a tribunal having also discretionary power to relax provisions the purpose of which is otherwise attained.

Other principles, which are not so axiomatic, and require some explanation, are as follow:—

1. That the experience of what are called model lodging-houses, such as the Peabody-buildings in London and other large towns, combined with that of barracks, workhouses, and schools, furnishes abundant evidence that what is termed density of population is not so detrimental physically as has been hastily assumed; because, in such buildings as are referred to the rate of mortality is much less, with a density of 1,500 persons to the acre, than it is in ordinary small houses, with a density of only 250 to the acre.
2. That the health of a community is much more dependent upon food, clothing, and personal habits than upon the arrangements and construction of dwellings or workshops; for however perfect may be the arrangement and construction, they may be entirely neutralised if the food is bad, the clothing deficient, and the personal habits filthy. . . . . .
3. That the measure of sanitary regulation, absolutely necessary, is to be sought in those buildings in which the arrangements of all kinds are of the simplest or rudest description consistent with shelter, the test being afforded by the rate of mortality as compared with that in buildings of the very best character for people of the same habits.

For nearly forty years the writer's attention has been directed to the sanitary requirements of large towns, especially in Liverpool; and in 1867 he directed the attention of the sanitary authority of that town to a property known as Richmond Fair. Originally constructed for a cloth-hall, like those in use in provincial fairs, the several shops or stalls, built round a hollow square, have been converted into dwellings, which, in the majority of cases, consist of one room only; they are arranged in two flats, access to the upper being attained by two staircases and covered galleries; a few of the upper houses have a second story, and some of them have the advantage of a window front and back; the rents, he was informed, range from 1s. 9d. to 3s. 1d. per week; the conveniences are in common, and the buildings generally in a dilapidated condition. One of the buildings entered was occupied by a craftsman, who was out of work, had tried 'portering,' his wife said, but had not earned anything for some days. The dwelling consisted of one room only, say 200 ft. in area, and 9 ft. high. The inmates were the man, his wife, a son of sixteen, and three young children; there was one bed; those that could not be accommodated in that slept on chairs; the rent was 2s. a week. This seemed a fair sample of the bulk of the property, which consists of eighty dwellings, and covered altogether about 2,200 yds. of land. At the rate of five inmates to each dwelling, the total population would be 400; or at the rate of 880 persons to the acre, or of 563,200 to the square mile,—a density rarely exceeded. Yet, with all the disadvantages indicated above, and the absence of personal cleanliness, the writer was assured by residents that the general health is extremely good; one person said they never had cholera or fever, and people never die here except from old age. These reports of the sanitary condition of this property receive general confirmation from the District-Registrar, who said the mortality was very low, and chiefly confined to infants and old people; he thought there had been one death from cholera. Inquiry in the neighbourhood elicited that the conduct of the inhabitants was very good.

Most of the dwellings above referred to are built "back to back," abutting on the property of another owner, therefore the only space "uncovered by buildings" is the hollow square, from which it may be inferred that open space on more than one side is not *essential*, however desirable it may be. Many persons seem to think that a window front and back secures thorough ventilation; such an arrangement certainly secures a thorough draft, when both the windows are open, consequently they seldom *are* open at the same time. In fact, careful observation shows that windows, as a rule, are never open, even in houses of the first class; and fireplaces, when not used as such, are usually closed with a register or a chimney-board. The advantages of open spaces around buildings appear to be both over-estimated and misunderstood. A building at the corner of two streets is more favourably situated than another which has merely a frontage to one street with a small court and narrow passage in the rear; much more favourable is the position of a building which is bounded by three or four streets. To compel a part of the space so situated to be left unbuilt upon will, in many cases, involve what appears to be the wanton waste of valuable property. If the area of uncovered space is in due ratio to the cube of building, its appropriation as street, square, garden in common, or otherwise, becomes comparatively indifferent, care being taken to prevent the space from being cut up into small, confined, neglected, and dirty patches,—the usual aspect of courts attached to small houses in towns.

If the space must be cut up, then it appears desirable to make the separate portions subsidiary apartments for cleansing purposes, covered over by a roof or upper story, with as little inclosure vertically as practicable. For, as respects the inhabitants of small houses in small streets, it may be observed that, though they seldom open their windows, they usually keep the house-door open whenever the weather permits; and in Richmond Fair it is habitual to keep the door open even in stormy weather, the verandahs giving the needful shelter. It is, of course, very desirable that this mode of 'keeping open-house' should be encouraged, as the cubic capacity of the living-room is thereby indefinitely increased.

4. The prejudice which prevails against water-traps as a security against the escape of sewer-gas into houses, appears to arise from forgetfulness of the very obvious facts that in a well-ventilated sewer, drain, or pipe, the gas cannot accumulate so as to exert any pressure; and, that it is so diluted by admixture with atmospheric air as to be harmless. It is possible for the water actually in contact with the sewer gas to imbibe a small quantity; but the occasional change of the water in the trap will remove any injury from that cause. After having had daily experience for several years past of the use of several hundred water-traps, by the tenants of an important estate, the writer is confident that a well-constructed water-trap, if properly applied and protected by ventilation, is a perfect precaution against any danger or annoyance through the escape of sewer-gas.
5. To a similar oversight must be attributed interruptions to the unbroken stream of drainage which are sometimes designedly introduced into drains, the danger of deposit, and of consequent local fermentation, being disregarded. As fermentation does not usually commence until some hours after any substance has been exposed to the air, it appears obviously desirable that, where fermentation is to be avoided, the substances should be removed with the least practicable delay; and, consequently, that the connexion of drains of all kinds with each other, and with the sewer, should be as direct as possible, without the intervention of cesspools or even traps; that in vertical pipes all traps should be placed as high as possible, so as to secure the greatest hydrostatic head, and the utmost scour. Neglect of these provisions, and the adoption of unnecessary traps, from over-anxiety to prevent the admission of sewer gas, have led too much annoyance and expense. It is clear that in a drain which is unavoidably almost level, any interruption, however trivial, weakens the scouring power of the stream, and favours the accumulation of sewer-silt, than which nothing can be more objectionable from a sanitary point of view. All such deposits are most favourable for the evolution of gas and the growth and propagation of germs.

The great annoyances which sometimes arise from drainage as at present constructed, appear due more to the negligent way in which the work is usually executed than to the arrangement and position of the drains themselves. It is desirable that every part of a system of drainage should be accessible in the readiest way which is practicable, so that any defect may be easily remedied, and additional drains connected with it at the least expense and trouble. It is probable that the imperfections arising from slovenly workmanship would be prevented, if no one is allowed to lay drains unless he is licensed for the purpose by the Sanitary Authority of the district; and by subjecting all persons so licensed to penalties for defective work, whether arising from the materials or the labour. In this way the men employed would be responsible for the proper construction of the drains according to the plan laid down for them.

6. Local Boards usually require the deposit of one or more of the drawings of a new building; in some cases they are very exacting in this respect.

This requisition is open to grave objections, as disclosing the internal arrangements,—which, in various factories, is detrimental to the proprietors,—and as tending to deprive the architect of his *quasi*-copyright in the design, drawings, and specification. It is difficult to see in what way the Sanitary Authority is benefited by such injurious demands. Cases have occurred in which the drawings required have been deposited, and found to be in accordance with the regulations of the Local Authority, but in which the buildings have proved to be not in accordance with the same regulations, the deviations not having been detected until the buildings were approaching completion. The deposit of drawings, then, appears to have the effect of beguiling the surveyor into false security, and of preventing that watchful inspection which is often very essential. That the plans of drainage should be submitted for approval is in many cases very desirable, as modifications in the system may be suggested and adopted with advantage; but it is otherwise with the general distribution of space throughout the structure; for in that the proprietor, or vendor, according to the received principles of trade, must be presumed to be the best judge. Of course, the regulations or bye-laws of the district must be enforced; but that can be done most effectually in the structure in which the deviation from the bye-laws,—that is, their evasion,—is most likely to be attempted.

7. The experience acquired under the Metropolitan Building Act appears to show that its provisions are better enforced by practising architects than by surveyors appointed for that purpose exclusively; and it seems very

desirable that the system of supervision which has prevailed for so long in the metropolitan districts should be extended throughout the country. In rural districts, where the amount of building is very limited, and architects but sparsely scattered, it is probable that two or more local Boards will appoint the same architect their district surveyor. In this way the Boards would secure the assistance of men of superior intelligence, and, probably, of more honourable character,—both qualifications essential to the impartial and reasonable execution of statutable enactments.

It has appeared to the writer that, for the purpose of a conference, it was preferable to propound general principles which should govern the compilation of bye-laws for the regulation of building, than to enter on a discussion of the model which has been issued by the Local Government Board. When the principles are established it ought not to be impossible to frame a code which shall harmonise with them. A discussion of the model bye-laws themselves would involve a mass of detail which would prolong the discussion unreasonably and impracticably.

Any one who will compare the principles enumerated above with the model bye-laws cannot fail to see that they are utterly irreconcileable with many provisions in the latter. The defects of the model bye-laws have been very fully considered by the council of the Liverpool Architectural Society, and their objections stated in a report dated 6th of November, 1877.

That report has been republished in some of the professional journals, and is probably known to many of those who attend the conference. In the tenor of that report, which he assisted to prepare, the writer wishes to express his concurrence."

Mr. Cates also stated that Mr. Heneyman, who took great interest in the discussion of this subject, and who, at the last Conference, read a paper* containing suggestions many of which were embodied in the report on the Model Bye-laws submitted to the Local Government Board by the Institute, had been suddenly called back to Glasgow, but he had left the following notes to be read to the Conference :—

"The greatest care should be taken in framing a General Building Act to keep out all reference to sanitary matters, except such as are necessarily dependent on structural details. These, it will be found, are few, and can easily be defined. It would be the duty of the surveyor under the Building Act to see that they were attended to,—the *sanitary* authority, as distinct from the *local* authority, should have nothing to do with it. The tendency is (especially in Scotland, where the existing Health Act is greatly inferior to the English Act) to confound the two, which would inevitably lead to confusion. For example, the Glasgow authorities are at present seeking to have it enacted, as an addition to their present building regulations, that no room in a domestic building shall have less than 10 ft. height of ceiling. Now, this is utterly absurd as a building regulation. If such regulations as Nos. 55 and 58 of the Model Bye-laws are attended to, a house may be as healthy with even 8 ft. of ceiling as with 10 ft., *if, after it is built*, the officers under the Public Health Acts do their duty, and prevent overcrowding, &c. People should be bound to erect houses with proper provision for light and ventilation, but arbitrary restrictions, which have no *necessary* connexion with the healthiness of the dwelling, should on no account be tolerated. I have repeatedly seen, both in town and country, two houses both exactly alike so far as the building was concerned, built by the same builder and finished exactly alike, with high ceilings and windows, and fireplaces in each room, presenting the most striking contrast in the matter of health, which no building regulations conceivable could have prevented, but which the provisions of a Public Health Act most certainly could. In the one you might find a man and his wife and a couple of children: everything bright, airy, and wholesome. In the other, the same houshold, with the addition of four or five adult lodgers; the fireplaces, except the kitchen, filled up with boards, and most probably papered over; and everything filthy, stuffy, and stinking.

Can the Conference, backed up by the Institute, bring about either of these practical results?—

1. Induce the Government (by memorial, deputation, or otherwise) to take the matter up in earnest, and give us a Building Act pure and simple, suitable for both urban and rural districts, throughout the whole country (not forgetting Scotland).

Or, failing this,—

2. Can the Conference, or the Conference through the Institute, bring some pressure to bear upon local authorities promoting private Bills dealing with this matter, to induce them to take the advice of architects practising in their locality before deciding upon the details of their measures, or the advice of the Institute, or of local societies through the Institute?

If there is not to be a general Act, it is, I think, of the very first importance that the framing of numerous independent Acts should not be left in the hands of local authorities themselves. It might be expected that the authorities in such a city as Glasgow, for example, when desirous of obtaining new building regulations, would be glad to have the advantage of receiving the opinions of such men as compose the Glasgow Institute of architects—many of whom are, from their extensive and varied experience, well qualified to give most valuable advice. But what is the fact? Without giving the architects, or any other class of the community, any opportunity of discussing the details, they, with unseemly haste, seek to get Parliamentary sanction to regulations of the most preposterous character (one of which I have already referred to) affecting vested interests and the value of property to a serious extent. The Glasgow Institute have, of course, protested against the course which has been adopted, but, obviously, where they are ignored with such marked intention they can hardly with dignity offer their advice. *Can the Conference do anything to convince self-sufficient Corporations how senseless and detrimental to the interests of the community such conduct is?* If not, much mischief must soon be done if the regulation of buildings it to be left to private legislation."

To the discussion which ensued we shall return.

* *Builder*, vol. xxxiv. (1876), p. 634.

CONCRETE AND FIRE-RESISTING CONSTRUCTIONS.

At the Conference meeting on Thursday evening, as already stated, Mr. George Godwin presided, and Mr. Arthur Cates read the paper which we printed last week (pp. 585-86).

Mr. Godwin, in opening the proceedings, observed that the two subjects to be discussed were matters of extreme importance, as all present would know very well. In fact, they had only to recollect that there were more than 2,000 fires every year in London alone, and that the money-loss thus sustained, irrespective of the loss of life and the amount paid for insurance, must be counted by millions annually, to fully appreciate this. Yet, nevertheless, we, strange to say, went on in the same insane way as of old in building "match-boxes" rather than houses, mainly, as it had always seemed to him, from two causes; firstly, our iniquitous system of building on short leases,—a system which was gradually handing over to the landowners the greater part of the accumulations of the middle classes; and secondly, the want of precise knowledge as to how best to avoid the evils attendant on the prevalent modes of construction. If Mr. Cates's paper and the discussion which might follow should tend to make that knowledge more precise, the Conference would, in that alone, have done a great thing.

Mr. Cates having read his paper,

The Chairman said they would now be glad to hear any gentlemen who had anything to say on the subject, and he thought it would be well if the meeting would follow the reader's suggestion that they would confine their remarks, in the first place, to fireproof construction, leaving their observations on concrete proper to the afterpart of the discussion. The time had gone by when it was necessary to inquire whether concrete was a good building material or not; concrete when it *was* good, was "very good."

Mr. Matthew Allen said he was a practical builder, and his attention was first drawn to the question of concrete in connexion with the erection of dwellings for the working classes. Up to the time he took out his patent it was impossible to build, as a remunerative speculation, large blocks of workmen's dwellings, on account of the Building Act demanding that all the balconies, passages, staircases, &c., must be fireproof. He found that by burning clay or refuse from gas works, and mixing the burnt material with Portland cement, he obtained a fireproof material which possessed the additional important merit of great strength. Such was its fire-resisting capability, that he was now using it for furnaces as if it were fireclay. As already mentioned, he had at first taken out a patent for the material, but after the lapse of four years he surrendered his rights in the patent, and gave it up for the benefit of the public. He was glad to find that the material was now being very largely used. He had carried out his principle of construction in new buildings for the Industrial Dwellings Company, over which Sir Sydney Waterlow presided. In those buildings the lintels, steps, copings, keystones, and, in fact, everywhere where stone would otherwise have been used, his artificial stone or concrete was used, made in moulds to the required shape and size. He had since carried out a block of buildings,—middle-class dwellings,—in Manor-road, Stoke Newington. Here the staircases and ceilings were entirely of his fireproof material, and, in fact, there was not a bit of wood in the whole construction which could not be removed without disturbing a brick. Until people got to know that it was just as easy to build both for stability and immunity from risk by fire, there would not be much improvement. A brick would exist for generations,—for ages, indeed,—uninjured; it was not possible to calculate its duration. Wood, on the other hand, was, if not burnt up, rotted to pieces in a very few years. As regarded fireproof bressummers, he thought the principle Mr. Hyatt had acted upon was the correct one; but he used about five times too much iron, and had not got enough concrete over the top of the iron. With all the lintels he (Mr. Allen) had used,—with a small piece of iron running through each,—he had never once had a failure. He treated iron in a building just as the bones were treated in the animal economy, *i.e.*, clothed it. As the bones gave strength to the human frame, so the iron gave strength to the various parts of a building; but just as it was needful to cover bones with flesh, so was it necessary to cover iron in a building with some incombustible material. Buildings erected on his principle would, he felt sure, be as perfect at the end of the lease as when just completed. Looking down on London from the dome of St. Paul's on the previous day, it was apparent at a glance that the city was being rebuilt,—had, indeed, been half rebuilt already. But how? As if it were built expressly to burn. Costly stone fronts many of these new buildings had, but they only concealed from the outside the 9 in. by 3 in. joists which supported the floors, and which, once a fire took place, would allow the building to be completely gutted,—would, indeed, feed the flames. Then, again, there were well-holes and staircases which seemed expressly intended to spread a fire when once it broke out. In ordinary houses, why should quarter-partitions be tolerated? Why not have 4½ in. brick walls? The new Building Act was going to make staircases still more perfect as agents for spreading fire, by compelling an opening to be made at the top,—by taking out the "damper," in fact. Of all subjects that could be discussed by that Conference, he thought fireproof building was first in importance. As a practical builder he was prepared to build fireproof buildings. His plans had been before the Metropolitan Board of Works for many years, and highly approved of by that body. He thought the time was not far distant when the architect and the builder would see the necessity of working more harmoniously together to attain the end in view. It was not pleasant for a builder of fifty years' experience to be told by architects that he did not know his business. Clerks of works were brought up as foremen in builders' shops, and architects generally got the best of them to act as clerks of works, and, in many cases, to teach them what they did not know themselves. The architect had an important part to fill in connexion with building; but, after all, he was not everybody. The diagrams on the walls, and concrete construction generally, testified to the fact that builders, and not architects, led the van.

Mr. Cates reminded Mr. Allen that the drawings on the wall and the paper which had been read referred to two systems of fireproof construction which had been devised by architects, viz., the systems adopted by Mr. Hornblower and Mr. Whichcord respectively.

Mr. Allen replied that in those systems of construction fireclay was used. Of course, it was a very good material, but was far too expensive. He claimed that the concrete which he used was equally as good as fireclay for

heat-resisting purposes, and it was certainly much cheaper. Mr. Lascelles, the well-known builder, of Bunhill-row, had used, and was using, the material very extensively for a great variety of purposes, constructive and ornamental. It could be used for mullions, sashes, and doors, and it was possible to do without woodwork altogether.

Mr. Charles Fowler said that one reason why, as he thought many years ago, architects were unable to adopt fire-proof or fire-resisting construction was, that there had not been discovered, or there was not generally known, any material which, used with iron, would answer the purpose of protecting the iron. Our neighbours across the water in France had got such a material in abundance, and they largely availed themselves of it in floors and partitions. That material was the coarse plaster of Paris, which resisted fire admirably; and the floors of Parisian houses, which had now been used for a generation nearly, were based entirely upon the principle of bedding the iron in the material. It was found that floors constructed on that principle were very strong and very light, and, incidentally, such floors had been found to be fireproof. In this country it was quite recently that we had discovered a material which would answer the purpose of making iron structures fire-resisting. Mr. Matthew Allen appeared to be one of the first to adopt such a material. Others had followed in the same direction. There was one difficulty which arose from the use of fireproof construction throughout a building, and that was resonance. But although it seemed to be impossible to get fireproof buildings, carved, as they might be said to be, out of one solid block of material, without resonance, fortunately a new material, "slag wool," had cropped up. This material was obtained by driving a jet of steam into the waste slag as it came from the smelting-furnace, the result being a kind of incombustible cotton, tangled about and capable of being turned and twisted anyhow. It possessed the great advantages of being non-resonant and indestructible by fire. Such a material would be of incalculable value for putting behind partitions and between floors in order to deaden resonance. It was a question with many who had considered the subject how far cement concrete and ironwork could be trusted to adhere perfectly and work well together. Most, if not all, of the patentees of systems of fireproof construction, involving the combination of iron and concrete, adopted some artificial means for increasing or creating the adhesion of the two materials, such means often consisting in winding iron wire round the bars or plates of iron. If such expedients were really necessary, it would be interesting to know to what extent the stability of the structure depended upon them. He confessed that they had the appearance of being rather dangerous. Although, in case of fire, the concrete would no doubt protect the ironwork, yet the heat must penetrate the concrete and expand the iron, perhaps to an extent sufficient to disintegrate the concrete. Although a building so constructed would resist the action of fire once, was it equally certain that it would successfully withstand a second fire? In other words, was a so-called fire-resisting structure as strong and as fireproof after a fire as it was before? For instance, would Messrs. Waterlow's building in Finsbury, referred to in Mr. Cates's paper, be equally successful in standing a second ordeal by fire? Until these questions had been answered by practical experience it was difficult to feel perfect confidence in systems of construction which combined the use of two such diverse materials as iron and concrete.

Mr. Matthew Allen said perhaps he might be allowed to add to his former remarks by saying that, as to the question raised by the last speaker, whether his concrete would bear a second, or even a third or fourth fire, about five years ago he had used the material for setting a hot-water boiler, and it had stood a very great heat very constantly ever since.

Mr. Alexander Payne said that in reply to Mr. Fowler's remarks he might mention a case in which concrete had been used in connexion with iron and exposed to a great heat. About three years ago he had to carry out a manufactory at Oldham, in Lancashire, in which there were several large drying-floors. The flues from these were brought from one end of the building and there collected into a chamber lined with fire-brick from which one large main flue passed to the chimney. This chamber was covered with a dome of Portland cement concrete, with wrought-iron ring ties bedded into it to prevent the thrust. This was an instance of Portland cement concrete exposed to great heat and with iron embedded in it. With a view to this meeting he had written to the secretary of the company for whom the manufactory was built to ask if the concrete cover or dome had ever cracked or shown any weakness from the effects of the heat, and he sent the following reply from the manager at the works:—

"The underground flues are level until they meet the main flue just outside the end wall. At this junction they are covered by a concrete dome with stone slab 3 in. thick on the top. Although the heat at this point must have been immense at times, I never saw any signs of the concrete cover cracking."

Mr. W. R. Pullen, as the representative of Mr. Thaddeus Hyatt, invited gentlemen interested in the subject of fire-resisting constructions to visit Mr. Hyatt's new building, the "Patent Lens Light Works," Farringdon-road. He was sorry to say that Mr. Thos. Rickett, who had conducted many of Mr. Hyatt's experiments, was unable to attend the meeting.

Mr. Wm. H. White wished to be allowed to add something to what Mr. Fowler had said as to fire-resisting construction in Paris. The Parisians had been for many years far ahead of us in England in all matters relating to buildings intended to resist fire. When, in 1840, iron joists began to be generally used in Paris, owing to the strike of carpenters, the system of construction adopted was not new in itself, for just as the iron joists were embedded in plaster of Paris, so in the same way the wooden joists had been for at least a century and a half surrounded with plaster. All the wooden floors made in the time of Louis XIV. were constructed in that manner. Indeed, the very complaint just made by Mr. Matthew Allen about our miserable and dangerous 9-in. by 3-in. wood joists was identically the same as that made by Evelyn in his diary 200 years ago, when he compared the rough, inflammable wooden floors of London with the horizontal solid partitions and careful parquetry he had seen in Parisian houses.

Mr. J. Douglass Mathews said that the observations already made in the paper and in the discussions tended to show that, however perfect as fire-resisting structures some of the floors referred to might be, their cost would preclude their use. That was especially the case with the methods put forward by Mr. Hornblower and one or two others. It seemed to him that, until the question of cost could be solved, we should have to continue using "9 in. by 3 in. joists." Could that question of cost be solved? It certainly appeared to him that Mr. Allen had solved it in a very satisfactory manner, inasmuch as he was able to produce a fireproof floor and ceiling at a very moderate cost. It was now beginning to be generally recognised that the smaller the quantity of iron used in fire-resisting floors the better. Now, instead of iron being, as formerly, the chief material, concrete was paramount. He thought that the experiments which had been made by Mr. Hyatt would give architects very great confidence in concrete. Mr. Brannon used so very little iron,—it could hardly be called more than wire,—in his floors, that one almost feared to adopt them. He (Mr. Mathews) had made use of some of Mr. Brannon's iron doors, and remarkably light and satisfactory they had proved to be. One of the systems not mentioned in the paper was that introduced by Mr. Moreland, which, as at first carried out, consisted of light lattice girders with corrugated iron laid across them, and covered with concrete. Mr. Moreland ultimately came to the conclusion that the corrugated iron was of little or no value except as a centering, and it was discarded. Another system not mentioned in Mr. Cates's paper was that of Messrs. Homan & Rogers,—"Phillips's" plan,—which appeared to be a very satisfactory one. One great obstacle to the use of some of these fire-resisting "floors" was that, instead of being floors, they were only ceilings to the apartments below, the floor proper being laid on the top of them. If the floor formed part and parcel of the construction, it would be much better. One great disadvantage attending the use of concrete was, as Mr. Fowler had remarked, its too great facility for conducting sound.

After some remarks by Mr. Roberts, an operative plasterer, who claimed to have been the originator of some of the methods of construction referred to during the meeting,

Mr. Jennings observed that the chairman had made reference to the losses entailed by the destruction of houses by fire, but, on the other hand, any one would find, by calculation, that the interest on the money expended in rendering buildings fireproof would be much greater in amount than the sums paid for insurance. Therefore, as a matter of pounds, shillings, and pence, although it might be said that a great deal of money was lost, it was not wholly lost, or the insurance offices would cease to be remunerative concerns. He thought that the whole subject of fire-resisting constructions was one which architects would do well to take up and study, for to most of them opportunities would often occur of carrying out such systems where the cost was not too great. One important point connected with the subject was that buildings supposed to be "fireproof" were often made to carry such great weights on their floors that they fell in almost directly the heat affected the iron supports. The law ought to insist upon such structures being made stronger, or else they should be less heavily weighted. There was a strong feeling at the present time that stone staircases would not withstand fire, but he never knew a case in which a stone staircaes had not lasted long enough for all who were in the house to pass down it.

Mr. Swain said that he believed his firm (Evans & Swain) were the only patentees who had devised a fire-proof wood staircase, with the soffit and risers protected by plastering, the treads being removable. Although, as the last speaker had said, it was possible that a stone staircase would last sufficiently long to enable those in a burning house to escape, the safety of the firemen and salvage corps men should by no means be forgotten, for they had important duties to perform in rescuing property. Unless staircases could be made of a really fireproof material, the firemen would not venture on them. Mr. Tozer, chief of the Manchester Fire Brigade, had expressed his opinion that the staircase introduced by the speaker's firm was the best he had seen, and he should have no objection in allowing his men to pass up or down upon it, though it might be surrounded by fire. Mr. Tozer also expressed a similarly favourable opinion with respect to the fireproof floors * introduced by his (the speaker's) firm.

Mr. Drake said that he had had twelve years' experience in the erection of concrete and fire-resisting structures, and ten years ago he had perceived the non-necessity for heavy iron girders. He had used light bowstring girders, and had constructed a number of very light but remarkably strong floors in various parts of the country. He had also constructed several concrete staircases, with iron imbedded in them. The steps of one of these, erected in 1871 at his own house, had a bearing of 2 in. into the wall, and every step had stood the test of being weighted with 15 cwt. After all that had been done in the use of concrete and iron, it was still a moot point what amount of iron ought to be used,—where, in fact, it was necessary to begin to supplement concrete with iron. He thought Mr. Hyatt was deserving of great thanks for the experiments he had carried out and published for the benefit of everybody.

Mr. Homan remarked that it was a mere matter of calculation as to the amount of iron required. Mr. Allen's remarks had been very practical and very sound. Iron should always be covered by the concrete, because when so covered it was practically indestructible by fire. As to insurance, he was sorry to say that insurance offices, as a rule, did not favour fireproof construction. When he (Mr. Homan) first introduced his system, he brought it before the notice of two fire offices, the Sun and the Alliance, and they agreed that where his system of construction was adopted they would charge the minimum rate of premium. He asked them to charge only something like the Paris rate of premium on such buildings, viz., from 4d. to 7d. per 100*l.* insured, but they refused, with an implied intimation that they did not intend to commit the "happy despatch." His firm (Homan & Rogers) last year finished the Howe Bridge Mill, in Lancashire, and the owners, owing to the fire-resisting construction, saved in insurance premiums to the extent of 600*l.* a year. Other mills similarly constructed were saving on fire premiums to the extent of from 400*l.* to 900*l.* a year.

Mr. Butler explained his system of rendering fireproof the ordinary wooden floors supported on timber joists. By means of terra-cotta or fire-clay tiles or slabs, and concrete and plaster, he was able to render such floors fireproof,

* Described in *Builder*, vol. xxxv. (1877), pp. 116, 566.

at a cost of about 2*l.* 10s. per square of 100 ft. Some experiments had been tried that afternoon, in the presence of Mr. Vulliamy (the Superintending Architect to the Metropolitan Board of Works) and a number of district surveyors, on a specimen floor constructed on that principle in Victoria-street, and with the most perfect success,—a fire having been burning under it for two hours without having the slightest detrimental effect on it.

Mr. A. D. Dawnay remarked that the construction of a flooring which should be capable of being adjusted in its parts for various strengths to meet the requirements of either dwelling-house or manufactory, composed of such entirely incombustible materials as were usually at hand, at a cost likely to induce an almost universal use, practically engaged his attention some ten years ago, at about the time when rolled iron joists were first imported into this country from Belgium in a general way. And in conjunction with others, a system was perfected which, though not absolutely unknown in some of its details, was wholly new in others. He referred to that of rolled iron joists and concrete of various compositions. At about the time referred to a system known as Fox & Barrett's was already in use. This consisted of rolled joists of various depths placed at an average distance apart of 2 ft., with fillets of wood laid between them bearing on the bottom flange with about ⅜ in. spacing. Concrete, either of Portland cement or lime, and broken brick or ballast, was then filled in to any required thickness. There was also a system in use in Belgium and France consisting of rolled iron joists, but having a lacing of hoop-iron over and under, which was embedded in the concrete. This system needed a flat centring being first fixed to receive the concrete. Fox & Barrett's system provided its own centreing in the wood fillets. On mature consideration it appeared probable (he spoke without the slightest prejudice) that, in case of a fire occurring under a Fox & Barrett's floor, the wood fillets would be partially or wholly destroyed, and the stability of the concrete endangered. The French system offered practical objections on account of the form of binding the hoop-iron rather than as to its incombustibility. Between these two kinds of floors a third was originated. In this, instead of wood fillets or hoop-iron, small bars of ⊥-iron, 1 in. by 1¼ in. to 1 in. by 2 in. according to the span, and having their ends jawed and set up to clip the flanges of the joists, were fitted between at 4 in. and 6 in. spacing. A centreing was then erected, and the concrete poured in in the usual way. With the ⊥-bar plan the iron joists were placed 3 ft. and even 4 ft. apart, it being found upon experiment that the concrete, assisted by the bars, was amply strong. Floors had been constructed in this manner for working loads of 3 cwt. and upwards per square foot, with 6 in. of concrete. The cost per square nine or ten years ago for iron and concrete was from 5*l.* to 8*l.* when joists only were used, and in the case of large spans needing a sub-division by girders, the cost was as much as 10*l.* The expensiveness of the system proved a considerable drawback, and many expedients were resorted to to lessen the cost; one was to abandon the jawing of the ⊥ bars, and simply set the ends up to correspond with the bevel of the flange. This, in turn, was given up, and the bars were cut to dead lengths, and laid upon the flanges. By this means, and adopting a 6-in. gauge, ordinary floors were constructed at 4*l.* 10s. per square; and, taking a large building having a fair proportion of corridors, at 4*l.* per square. In several instances, when unusually strong floors have been required, and depth could be spared, curved—either elliptic or segmental—⊥ bars and arched concrete had been successfully used between girders spaced 7 ft. to 8 ft. apart, and in 25 ft. to 28 ft. bearings. The arching of the concrete answered as a casing to the girders, excepting only to the soffit or bottom flange, but which in ordinary cases did not exceed 5 in. in width. The versed sine varied between 8 in. and 12 in. Arched concrete between deep joists 5 ft. apart, with a versed sine of 5 in., answered admirably well, both as regarded strength and resistance to fire. In the arched system with girders he found that there was practically no combined thrust exerted against the walls, and especially was this the case with elliptic arching. The cost of this method was from 6*l.* to 8*l.* per square, including girders. As opportunity served, he conducted experiments upon various spans, and came to the conclusion from the results that owing to the immense strength of well-made concrete, a saving might be effected by placing the joists closer together and giving up the ⊥-bars entirely. There was some difficulty in this at first, for want of a better form and section of joists. Circumstances, however, were propitious, and new sections were forthcoming. He ultimately adopted a plan of placing iron joist-binders at from 7 ft. to 10 ft. apart, and filling in between with light joists 15 in. to 18 in. apart. By this method the concrete wholly embedded the small joists, and became transversely joggled into the binders. This arrangement he still adopted, and found it not only a very economical, but a very strong combination; a floor of 6-in. by 5-in. binders, 15 ft. span, and light 3-in. joists of 7 ft. lengths, 16 in. apart, with concrete well mixed, composed of 8 of Thames ballast to 1 of 117 lb. Portland cement, formed a most rigid and satisfactory structure, capable of a safe working load of 1½ cwt. per square foot. Spans of 20 ft. and upwards were similarly constructed in bays divided by main girders and subdivided by the binders and small joists. Of course, the ultimate well-being of such work lay in the concrete. If it were done slovenly, or composed of indifferent materials, the result was one of imminent danger. Lime concretes were not, in his experience, satisfactory. If Thames ballast were used it should be perfectly free from loam or foreign deposits, and not too coarse. If the former, it might fall without notice; if the latter, it would not work up "fat." A short time since he constructed several squares of pit-ballast concrete and Thames-ballast concrete side by side, mixed with the same make of cement. After the work had remained three days he had the centreing struck. That made with pit-ballast fell almost without notice about an hour after, but the other remained sound and good. Ballast concrete was the heaviest construction per square; next came broken bricks to pass a 1½ in. ring. Of the two, he preferred the latter; it was lighter, and though more "hungry" than ballast, except when a good proportion of chips and fine particles were produced in cracking, it gave an excellent floor. By experiment on a small scale, the broken brick concrete was undoubtedly the best in a fire. The ballast did not get injured, but the exposed surfaces of pebbles and flints which might happen to form excrescences on the surface blew and cracked, and would convey to the inexperienced an idea that it was unsafe. Bricks, being already burnt, had no tendency to fly. Next to bricks, he had largely used burnt ballast or burnt clay. This made an excellent and the lightest floor, but it was very "hungry," and took more cement than ballast or broken bricks. A soft, cakey, or crumbling ballast should be avoided, and only a hard-burnt brittle kind used, containing its own fine stuff also hardly burnt. Too much care could not be bestowed upon burning clay for fireproof floors if a good result were desired. As to cement, it was beyond controversy that bad cement spoiled any work. One advantage of the system he was describing was that the ceilings were perfectly flat, and might be plastered immediately upon the concrete without any preparation,* which in common work might be finished with two coats. It was found in the early construction, that the situation of each joist might be traced in the ceiling by a line of whiteness uncommon to the general surface. This was owing to the non-absorption of moisture by the iron, but after a few times of clear-coling and distemper, the whiteness disappeared. In the present method, the concrete was kept down below the binders ⅝ in., leaving a kind of channel with a side key for a roughing up of Roman cement and haired mortar, and it was allowed to set before the plastering was laid on. Work so executed left no trace whatever of the joists or binders. It might perhaps be thought that in an extensive fire considerable expansion might take place, and thus not only endanger the concrete, but the walls; but so far as experiment had gone that was not the case. There did not appear to be a sufficient bulk of iron in each joist of a floor to cause a destructive expansion, and in consequence of the undersides being protected by ¾ in. of plastering and ¾ in. of concrete or Roman cement filling in the heat did not act upon the iron with any serious result.

Mr. W. H. Lascelles, of Bunhill-row, exhibited and explained a number of his many and varied applications of concrete to building purposes. These comprised mullions and other architectural features which have been supplied by him for buildings erected by Messrs. R. Norman Shaw, R.A., A. Waterhouse, A.R.A., Gilbert R. Redgrave, the late W. Fogerty, and other architects. Mr. Lascelles remarked that not only doors, but window-sashes could be, and were, being constructed of concrete, with a very small quantity of iron embedded. The concrete used in all his productions was the same as that introduced by Mr. Matthew Allen.

Mr. Godwin, in closing the discussion, after a brief reference to the mention made by Mr. Cates of his early bantling, the "Essay on Concrete," to which the first medal of the Institute was awarded in years gone by, said that time would not allow of the further discussion of the subject, or of special reference to concrete proper, as to which much more might be said hereafter, particularly as to the possibilities of treating concrete artistically, with great usefulness. There were one or two disjointed matters as to which he wished to say a word. Reference had been made to the matter of cost, and some gentlemen had at once put aside the question of the desirability or the practicability of attempting to erect fireproof constructions, on account of increased cost; but cheapness of first cost ought not to be aimed at to the exclusion of all other considerations. It should be one of the duties of architects to endeavour to persuade the people that to build well was to build cheaply. On the Continent, they did not sacrifice everything to cost,—although it was true that abroad they did not labour under the incubus of our system of short leases. Only that morning he had received a letter from Dr. Schliemann describing a house he was building for himself in Athens. In that house the floors were formed of fireproof arches covered with a concrete mosaic floor, and there was no wood whatever in the house except the doors. If that could be done in Athens, why should not we do it in London? One inference to be drawn from the discussion was that a great deal too much iron was used in some fireproof floors as hitherto constructed, and no doubt in many cases less iron would suffice, provided that the concrete was good; for in using concrete it should always be borne in mind that unless it were thoroughly well done, with good materials and by men who could be trusted, it was a deception and a snare. For instance, though he did not wish to throw cold water on Mr. Brannon's process, to which allusion had been made, he had vividly in mind an instance where somebody who did not perhaps understand Mr. Brannon's mode of construction had formed a large roof over a shop, which ultimately fell, the materials never having properly aggregated, and killed a man who was below. Now, he did not mean to say that there was the least error, either in the theory or in the prescription, but what he did insist upon was that unless concrete work was well done, it was worth nothing. To show how slowly things were taken up and pursued in England, he was reminded by what had been said in the discussion as to the use of plaster of Paris that twenty years ago Mr. William Hosking, who did many original things, formed a floor in one of Clowes's printing-houses precisely in the manner referred to, embedding the whole of the woodwork in plaster of Paris. He believed that the floor stood to this day, and had succeeded admirably; but it was curious to find that, when such a thing had been attempted, and found to succeed, and was spoken well of, yet nevertheless, it was allowed to die out. He trusted that what had been said then, and what might be printed in the "Transactions" of the Institute and in the professional journals, would lead to a thorough review of the whole question, and to an endeavour to lead to an authoritative decision as to the best methods of fire-proof construction. Architects would pass through an exhibition of building appliances and materials, but few of them thought of using any of the appliances or materials they saw there. Of course, as he well knew, difficulties arose to prevent the introduction of novelties, either with the client as to their cost, or from the architect's disinclination to incur responsibility for their possible failure. Mr. Jennings had remarked, upon the subject of cost, that it was practically more advantageous to build houses that would burn rapidly than houses that were fire-proof, because, by means of insurance, the owners of the property were compensated for loss by fire

* The floors and staircases of the new wing of the Charing-cross Hotel, and the promenade roof of the Hastings Aquarium, just opened, are similarly constructed.

but such an argument hardly needed to be refuted. Were such a system to be generally pursued in other matters, the nation would soon be reduced to poverty.* The question of fireproof staircases was a very important one, and had received an interesting illustration in the case of the concrete stairs described by Mr. Drake as having sustained a load of 15 cwt. on each step, one end only being inserted into the wall. With a fireproof staircase there could be no possible objection to having an opening at the top, as objected to by Mr. Allen, and, indeed, it was in most cases necessary for ventilation and health. Want of time precluded him from making further remarks, as one point would lead to another, but in bringing the discussion to a close he would wish to thank the several gentlemen who had attended to afford the meeting information as to their own patents and contrivances, which had been done in the most reticent and admirable manner, without any display of self-seeking or the urging of personal claims. Having announced that a visit would be made on the morrow to Mr. Kirkaldy's Testing Works, where, he said, many valuable "wrinkles" might be picked up, Mr. Godwin concluded by moving a vote of thanks to Mr. Cates for his paper, which was an able synopsis of what had been done in the way of concrete construction, and, this having been carried by acclamation, the meeting terminated.

VISIT TO KIRKALDY'S TESTING WORKS.

ON Friday morning a visit was made to Mr. David Kirkaldy's Testing and Experimenting Works, 99, Southwark-street. The principal entrance to the premises is appropriately enough inscribed with the motto, "*Facta non Verba*." The patent testing machine was shown in operation under thrusting stress, testing specimens of wood. The particulars of these experiments, together with some information as to Mr. Kirkaldy's testing machine, and what is done by it, we have given on p. 624.

THE ROOF OF THE CORN EXCHANGE, MARK-LANE.

At the Conference meeting on Friday afternoon, the 7th inst., the following paper by Mr. Edward I'Anson, F.G.S., was read by Mr. T. H. Watson, in the unavoidable absence of the author. Mr. E. M. Barry, R.A., presided:—

The Old Corn Exchange in Mark-lane, London, having fallen into decay, and the market, which had already been considerably increased by an addition to the area of the original market space, being still insufficient, an adjoining piece of land has been acquired, and a new Exchange is now in course of erection on the enlarged site. The building will be about 100 ft. in width, and, after long deliberation, it has been determined that it shall consist of a block about 40 ft. in depth next Mark-lane, containing, on the ground-floor, the staircase, vestibule, &c., and on the first floor a flour-room; and in the rear of this block a central area or nave surrounded on three sides by aisles. The nave will be 60 ft. in width, and the aisles each 20 ft. The nave is separated from the aisles by an arcade, the arches of which have a span of 20 ft., and the height to the top of the cornice over the arches is 30 ft., measured from the floor. The roof over both aisles and nave is carried by curved ribs of wrought iron, each of which springs from the floor, has a span of 100 ft., and rises to a height of 61 ft. 9 in. from the floor, and is seated over one of the columns of the arcade. That part of the rib which spans the nave is semicircular. At the floor level each rib is bolted down to the brick pier built to receive it, and secured to one of the iron girders which, running across the Exchange from side to side to carry the floor, acts also as a continuous tie applied at the springing or lowest part of the rib. The iron ribs, like the columns of the arcade dividing nave and aisles, are 20 ft. apart from centre to centre. As to the construction of the roof, which has been the result of most careful consideration, I do not here purpose to make any remarks, my present object being only to describe the iron ribs which it has been decided to use in order to carry it.

The profile of the rib having been determined, the question was what section should be given to it, and under the advice of Mr. William Barlow, C.E., the following dimensions have been adopted:—The depth of the semicircular portion which spans the nave is at the apex 2 ft., and gradually increases, until at the point where it springs from the top of the nave arcade it is 3 ft. 10 in. in depth. The depth of that portion which spans the aisle is, for the vertical part 1 ft. 9 in., and for the curved part 2 ft. The rib is made up of top and bottom plates, web and angle irons. The dimensions of these parts are (with the exception of the web, which, as before stated, varies in depth) uniform throughout, and are as follows:—

Top and bottom plates, 11 in. wide and $\frac{5}{8}$ of an inch thick.

Angle irons, $4\frac{1}{2}$ in. by $4\frac{1}{2}$ in., and $\frac{5}{8}$ of an inch thick.

Web, $\frac{3}{8}$ of an inch thick.

The ribs have a tie at the feet, as already described.

It will be observed that the object to be attained was a rib which should bear upon the arcade but exercise no thrust upon it, and that the whole rib, securely fastened at the bottom, should be perfectly rigid throughout. In order to test the capabilities of the rib, a small tin model was made, and, being heavily weighted, showed a tendency to rise from its seating on the arcade, demonstrating the necessity for giving considerable stiffness to that part of the ribs which would span the aisle. This model represented correctly to scale the span and height of the rib, and also its profile, but did not represent with anything like accuracy the sectional areas.

On Mr. Barlow's advice, a model was made of two ribs one-fourth full size. These were constructed of wrought iron, and built up with flanges, plates, and angle irons all riveted together, and were accurate representatives in every detail of the proposed ribs. They were made by Messrs. Moreland, and carefully tested at their works in Old-street, St. Luke's, by Mr. Barlow.

To conduct the test they were placed on balks of timber, at the proper distance apart, and tied at the feet by iron ties. They were connected by purlins of iron placed in the exact position the purlins will occupy in the work. There were six purlins in all, three on each side of the roof, and all placed at levels above the springing of the rib from the arcade; that is, there were no purlins on that part of the rib which spans the aisle. As in the building the load will be received by the purlins, and by them transmitted to the rib; the test loads were suspended from the purlins also.

The following is a table of the loads successively applied, and the resulting deflections, the loads being in cwts. and the deflections in inches:—

Load on lower Purlin.	Deflection.	Load on middle Purlin.	Deflection.	Load on top Purlin.	Deflection.
$6\frac{1}{4}$	·01	$6\frac{3}{4}$	·06	$6\frac{3}{4}$	·07
10	·01	10	·06	$7\frac{1}{2}$	·08
15	·03	15	·11	$11\frac{1}{4}$	·13
20	·05	20	·16	15	·19
25	·06	25	·19	$18\frac{3}{4}$	·24

Under the last load, viz.: 25 cwt. on lower purlin, 25 cwt. on middle purlin, and $18\frac{3}{4}$ cwt. on top purlin, the extrusion at the point where the rib springs from the nave arcade was $\frac{1}{4}$ of an inch on each side; that is, $\frac{1}{2}$ an inch for the entire span from arcade to arcade.

The greatest load applied to the model was equivalent to about three times the calculated maximum of dead load which the rib will have to sustain in the building. When the weights were removed the model ribs resumed precisely their original form, no part having shown signs of undue strain.

The experiment was considered satisfactory, and the ribs destined to carry the roof of the new building are now being constructed under Mr. I'Anson's directions.

In the discussion which followed,

Mr. P. W. Barlow, F.R.S., in response to a call from the chair, said the roof was peculiar in its construction. It was of a form that had never previously come before him, and he hardly knew how to calculate its effects. He could get at them by approximation within certain limits, but inasmuch as the roof involved a double support, there was a degree of complexity about the structure which seemed to him to make it necessary to make the experiments referred to in Mr. I'Anson's paper. In the very much smaller model, made by Mr. I'Anson, there was a tendency to rise at a point over the line of the arches, when a weight was put upon the top. When, however, the roof came to be tested by the large model, that tendency did not show itself. He (Mr. Barlow) noticed that, as described in the paper, there was an increase in span to the extent of half an inch in the model, which would have been equal to 2 in. in the full-sized structure. He believed that some modification was to be made in the weights to be placed on the ribs. Instead of the masonry which it was at first intended to carry up on the purlins, iron and wood work would be used. The lights were to be vertical, stepped one tier above another, and formed in the walls carried upon the purlins, the space between each tier consisting of a horizontal flat of lead.

Mr. Haslehurst, from Mr. I'Anson's office, in answer to a question, said that the roof consisted of a series of vertical lights, and was covered with lead and glass arranged in strips.

Mr. T. H. Watson expressed regret that there were not some detail drawings exhibited, as they would have enabled the meeting to judge of the structure as a whole much better. He thought, however, that the form of the roof as a whole was extremely satisfactory, and enabled the architect to construct a roof depending upon small points of support. In order to get rid of the tie altogether, the expedient had been adopted of constructing a kind of counterfort. He should like to know from Mr. Barlow if he was satisfied as to what strain the girder below the level of the floor would have to bear in addition to carrying the floor. He noticed that the purlins varied in positions, some being placed nearer the extrados, and some nearer the intrados, there being three positions in all. The line that might have been drawn through those three points was suggestive of a curve, which might possibly have been found more beautiful than the extremely simple and almost barbaric beauty of the semicircle, which latter form had been adopted in the design. That form, although well suited to stone constructions, did not appear so specially suited for ironwork, which was a material which would have allowed of the use of another and more graceful form.

The Chairman (Mr. E. M. Barry, R.A.) said that in the paper it was stated that "the greatest load applied to the model was equivalent to about three times the calculated maximum of dead load which the rib will have to sustain in the building." Perhaps Mr. Barlow would kindly explain that. He understood that the model in question was about one-fourth of the full size. Was the weight applied one-fourth of what might be supposed to come upon the full-sized structure when finished?

Mr. Barlow.—No; one-sixteenth.

The Chairman said he should like to have the opinion of Mr. Barlow as to the value of models as tests of a structure. How far did the experience of engineers enable them to rely upon models as tests of strength? In the case of the Menai Bridge, designed by the late Robert Stephenson, the models tested were made, if he (the speaker) recollected aright, before the form of the structure was finally decided upon. Were engineers generally satisfied as to the general accuracy of the data derived from testing models?

Mr. Barlow, in reply, said that models would give perfectly accurate results if tested under precisely similar conditions to those in which the finished structure would be placed; but it was not always easy, or even possible, to ensure such similarity of conditions. Reference had been made to the Menai Bridge. Now, as a general principle, of course the increase of sectional area would increase with the square of the span, the weight of the structure itself went on with the cube of the span, and the deflections went on as the span. Now it required that one's head should be clear upon these three points. In the case of Mr. I'Anson's roof, where the weight of the structure itself was not a material part of the weight it had to sustain, an increase in the weight of the structure did not materially affect the span. But in the case of a very large structure, such as the Menai Bridge, one was obliged to take into consideration the weight of the structure itself. The model of the Menai Bridge was not tested under the same conditions as those of the bridge itself. The model was made of 75 ft. clear span, and in order to minimise trouble and expense, it was tested with all the weight in the middle instead of being spread all over the structure. Although

* The frightful results of such a principle as applied to ships will occur to most minds.

that was a very good test for the upper and lower members of the structure, it was not a good test for the sides, which in the structure of the tube itself were, owing to the misleading results of the test, made much too thick. In fact, there could be no doubt that the Menai Bridge was now labouring quite as much to support its sides as to carry the trains that crossed it. He said this with no disrespect to the memory of its designer, Robert Stephenson, than whom no man took more pains to make his work perfect; but the fact was that when that structure was designed engineers did not know so much about the application of iron to engineering purposes as we in the present day did. One thing perfectly clear was that no Menai tube would ever be made again.

The Chairman, in closing the discussion, congratulated the meeting on the interesting information which had been elicited from Mr. Barlow, not only upon the subject of the particular roof in question, but upon other important matters. It was to be regretted that the construction of the roof was not more fully illustrated by detail drawings, in addition to the section shown on the wall, but they had heard Mr. Barlow's expression of opinion that it would be a very successful and satisfactory work. That such would be the case would also be inferred from the fact that the structure was in the able hands of their old and esteemed friend, Mr. I'Anson. The roof was interesting to architects not only as exhibiting a somewhat novel application of iron on a large scale to an architectural work, but also as exemplifying the way in which the architect and engineer could work together, hand-in-hand. That was a matter of very great importance. The architecture of the future could scarcely fail to be modified by the scientific knowledge we now possessed of iron and other materials. It might almost be said that iron had been "discovered" as a building material within the time of the present generation. The construction of the great engineering works which had marked the present age would not have been possible without that extended application of iron to constructional purposes which had been the peculiar work of the engineers of our time. Architects had, perhaps, been a little behind-hand in the use of iron, and had been somewhat prone to stand aside and criticise what their brothers the engineers were doing. To criticise was not generally a very difficult task,—certainly it was not difficult in the case of the unartistic aspect of some engineering structures; but now that engineers had proved to the public at large the convenience of iron construction, architects were bound to avail themselves of the advantages offered by its use in their own designs. Wherever the architect and the engineer would unite their talents, the result was the more likely to be satisfactory. In the days of the Greeks, there were few constructional difficulties in the works they undertook. Going back still further, we found the works of the Egyptians exceedingly massive, yet, apart from the mere question of removing enormous blocks of stone from place to place, there was not much to be learnt from them as to construction. With the Romans, the introduction of the arch led to the use of smaller stones, while enabling wider spaces to be spanned than would have been possible with a trabeated system, and Roman architecture became in consequence, more interesting from the constructional point of view. There was very little doubt that had the Romans known as much about iron as we did they would have adopted it in their buildings, and would have taught us something of value as to its application. Passing to Mediæval times, there was the same readiness to resort to ingenuity of construction as was manifested by the Romans. Although necessarily limited as to the width of his arches, the architect of the Middle Ages was continually anxious to enlarge them, and to add to their height. We knew how such anxiety often culminated, — at Beauvais, for example,—in disaster. It could not be doubted that the architects of the Mediæval period would have ceased to restrict themselves to their comparatively small spans and often timid construction had they been masters of such a material as iron. At the present day, he thought architects were a little too apt to content themselves with looking backward to the construction of olden times, both Classic and Mediæval, without attempting to bring the resources of their art to bear on the materials placed at their disposal by modern science, and while they had been thus looking backwards, the erection of a great many important structures had passed into the hands of engineers altogether. Now, he believed that it was altogether out of the question that the art of construction should be in the hands solely of either architects or engineers. Both professions had plenty of work in their respective spheres. But it was greatly to be desired that the members of the two professions should work harmoniously together and should help each other. Engineers could aid architects in such structures of large span as had been described by Mr. I'Anson in his paper; and architects ought to be able to assist engineers in making some of their constructions agreeable to the eye, and rather more "things of beauty" than we were often accustomed to see in engineering works. In conclusion, he congratulated the meeting on having had so interesting an example of the combination of the architect and the engineer brought before it, and on the success of the Conference generally. As that was the last meeting that would be wholly identified with the Conference (the meeting to be held in the evening being partly in connexion with the Architectural Association) it was only right that thanks should be tendered to those who had assisted to make it a success by allowing the members to visit important works and buildings. The Conference had had the advantage of visits to St. Paul's Cathedral, the new Natural History Museum, and the new Law Courts, the various architects in charge of those buildings kindly placing themselves at the disposal of the visitors. Therefore he had great pleasure in moving that the thanks of the Conference be tendered to Messrs. Penrose, Waterhouse, and Street for permitting visits to be made to St. Paul's, to the Natural History Museum, and to the new Law Courts respectively; to the Duke of Westminster, the Earl of Ellesmere, and Mr. Holford for permitting visits to their picture-galleries at Grosvenor House, Bridgwater House, and Dorchester House respectively; and to Mr. Kirkaldy for arranging a visit to his testing and experimenting works in Southwark-street.

This was, of course, agreed to *nem. con.*, and the meeting came to a close.

TROY AND MYCENÆ.

At the final Conference meeting on Friday evening, the 7th inst., Mr. Bowes A. Paice, president of the Architectural Association, occupied the chair, and after some business connected with the Association had been transacted,*

Mr. T. Roger Smith read a long and interesting paper on rude Stone Monuments," to which we shall return.

Dr. J. S. Phené, F.S.A., followed with a paper on "Troy and Mycenæ," of which the following is an abstract, prepared by the author:—

The subject selected in this case was the construction of mural and architectural works by the builders of Cyclopean and other masonry in these localities. The reader regretted that by the title of the paper he was confined within geographical limits, from which he must deviate a little. Troy was passed over quickly, it being pointed out that there was little or nothing at Hissarlik to interest an architectural audience, the early masonry being (with one exception, consisting of an example of rectangular masonry of no particular character) rude stones placed without order, which Dr. Schliemann thought had been built up with mud used as mortar, but which appeared to him (the reader) to have had their interstices filled with earth by the rain and washing-in of centuries. Though near Bunarbashi, there was a tendency to pyramidal construction, similar to what he had found abundantly at and near Mycenæ, from Epidaurus as far westward as Hysiæ. The masonry of Mycenæ he divided into two classes, extremely opposite in design. "The enormous masonry of the walls, untouched by any tool, either in quarrying or construction, and the equally enormous masonry of the 'Treasuries,' wrought to perfection and highly polished, of probably the same period as the walls of the lower Acropolis." The first, or early Cyclopean work, was traced from the quarries to its position in the structures. The stone was evidently not worked by tools, and was shown to have been procured by taking advantage of certain fissures arising from natural weathering, which, by the insertion of dry wood and its subsequent saturation, would cause it to be easily detached from its bed. These fissures often approximated to the forms of the polygons found in basalt, and to this fact was attributed, not only the quaint forms of the ruder Cyclopean work, but by elaborating the suggestions of nature, the finished and often beautiful polygons of a later date, which preceded the graceful curves found in this kind of work in the base of the temple of Apollo, at Delphi and elsewhere. It was pointed out also that the ruder and earliest masonry of this sort was so similar in appearance to the natural rock on which the primitive cities were built, that although it formed their defensive works, they might be readily passed by the casual marauder, from their similarity to natural elevations; and that, on the contrary, when an imposing and threatening effect was required, natural elevations were enclosed by walls of masonry, which, rising from a level plain, as at Tiryns, gave an appearance of lofty towers and structures, which were, for a great part of their height, merely coatings to the natural rock. The architectural designs were dwelt on, and the bastion-like construction of Tiryns, though arranged with artistic engineering, was shown to be only such a coating to a rocky projection, the removal of which would have been troublesome, while it added immensely to the severe appearance of the fortress. With respect to the more artistic architecture of the Treasuries, the sculptured lions over the gateway, the decorated columns to the Treasury of Atreus, and the tombstones excavated from the sepulchres by Dr. Schliemann, it was shown that, though varying in artistic merit, the designs (principally those of the often-repeated spiral ornaments) agreed, and not only agreed with each other, but also with the gold ornaments found in the sepulchres. This, it was inferred, gave evidence of the introduction of a particular kind of foreign art workmen, as the design was not Greek.

It was first shown, in treating of the triangularly-arched galleries at Tiryns and Mycenæ, and the triangular openings above the lintels to the Treasuries and great gateway, that these, together with the battering, or inclination of the walls, and the diminishing width, towards the top, of the architraves to the entrance to the great Treasury, gave a strong evidence of Egyptian work; and that, as Strabo asserted, the builders of Tiryns came from the south coast of Asia Minor, *i.e.*, a place near to, and then in direct commercial intercourse with, Egypt, the introduction of Egyptian art was probably accounted for; and as *pyramids* were found over the whole of the Argolic district, and one of these pyramids had in it a gallery with the same triangular arch, this point seemed fairly established; but, that these constructions by Egyptian builders were subsequently decorated by men of another nation, seemed also clear. The decorations had been attached to the structures and were no part of them, and seemed of Asiatic design, and it was suggested that if the gold ornaments might be considered as having been any part of the spoil from Troy, it was probable that with them the victorious Greeks would have brought from Asia skilled workmen, who executed these decorative works for Agamemnon, and, perhaps, the stones found in the sepulchres (which are of inferior work, but similar designs) after his death, and under less strict supervision. Such workmen would probably have had a knowledge of Asiatic art generally, so that this view of the question would not be affected, even if subsequent discovery should prove these designs to have had their origin in districts from which either the Persians or Assyrians had issued. The use of the gold masks in burial pointed to a date earlier than Homer, and of course long previously to the Persian war and the battle of Platæa, or we must have found some account of it in the Greek poets. If subsequent discovery should show them to have been in use in the lands of the Assyrians or the Medes, it must have been there also a very ancient custom, at least coeval with or prior to the Trojan war.

The various quarries had been visited several times by the lecturer, who described their difference, and the modes of quarrying adopted. The huge Cyclopean blocks, procured, as he considered, from the facility afforded by natural fissures, and the usual quarrying by deep cutting, as in the coral rag beds in the Tretus Pass, from which the stones for the Agora and the sculptured slabs had been obtained. Of the former, he had found many rocky elevations east of Tiryns, literally scaled of their former weather-fissured coatings. A number of examples of progressive Cyclopean masonry were referred to as those discovered by the reader in the Island of Samothrace, and ranging from the

* Report of which will be given in our next.

most primitive unwrought stones to carefully-made polygons, examples of which were submitted by him to the learned societies of Athens. The great care in selecting suitable stones for quoins and other parts of structures upon which permanent stability depended was pointed out as always traceable, even in the rudest Cyclopean work; and to this, and the species of toothed bond formed by the jagged surfaces of the naturally angulated blocks, often laid as headers and stretchers as in modern brickwork, was to be attributed, he considered, the unaltered positions of masonry, which had remained vertical and undisturbed through many decades of centuries, though subjected to innumerable shocks of earthquakes. These walls had no buttresses, mortar, or any other than this natural bond. From this, he considered, was derived the knowledge of the tenacity caused by friction from the close-fitting joint, as shown in the tretagonal masonry of the subsequent Hellenic and Etrurian work, an example of the durability of which he had given in a short article in the *Builder* of the 4th of August last year, on the walls of Fiesole. The origin of the polygonal forms arose, it was suggested, from smoothing down the rude angulated fissured surfaces, instead of the waste of material and labour which would have been necessary to square them. The elevation of the vast blocks was described as simple and easy, the rude Cyclopean walls almost always acting as retaining walls to a natural elevation, hence an inclined plane was always at hand. That when such walls exceeded in height such natural elevation, their breadth was so great, sometimes 25 ft. in thickness, as at Tiryns, that an artificial incline of earth sufficient to raise the blocks successfully to the height required, was only necessary at any one point, as, once being raised, the blocks could be drawn along the summit of the wall itself on a rude platform or tramway of trunks of trees to the desired point. Examples of such inclined planes still existed, as was shown from photographs and descriptions by authors. The paper terminated with several quotations from Greek writers, referring to the custom of having the most honoured of their deceased leaders buried within the area of the Agora,—a custom still kept up even with us, where the church or cathedral forms the centre round which the civic court, judicial hall, the market, and its occupants are collected. This was brought forward to show that the enclosure to the dolmen lately discovered by Dr. Phené in Brittany* answered the descriptions by Homer, Pausanias, and others, as much as the Agora at Mycenæ, although the form of the Brittany one was oblong, and the Greek form circular. It was pointed out that the oblong was a local peculiarity of the dolmens of the part of Brittany where the island of Aval was situated. It was also shown that the term grand or great, applied to the island adjoining Aval, was in no way authorised from its dimensions, except as being the larger portion of the island of Aval, which had evidently been divided by the sea into two parts.

Notes of the discussion on these two papers will appear in our next issue.

THE JUBILEE OF THE INSTITUTION OF CIVIL ENGINEERS.

THE *conversazione* of the President of the Institution of Civil Engineers, held on the 3rd current in the galleries of the India Museum, is worth more than a mere cursory notice. Independently of the full illustrations of the latest progress of science which are brought forward invariably on such occasions, a special interest attaches to the date of Mr. Bateman's *soirée*. It took place, within a day, on the fiftieth anniversary of the granting to "Thomas Telford, of Abingdon-street, in our city of Westminster, esquire, a Fellow of the Royal Societies of London and Edinburgh, and others of our loving subjects," of a royal charter of incorporation, given "more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in nature for the use and convenience of man, as the means of production, and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation, and docks, for internal intercourse and exchange, and in the construction of ports, harbours, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power for the purpose of commerce, and in the construction of machinery, and in drainage of cities and towns." It is not often the case that a legal document, especially in the English language, speaks in terms at once so comprehensive and so precise. The duties of an engineer, and to some extent the future of the profession, are indicated in words which we shall, perhaps, not be wrong in attributing to the suggestion of the veteran Telford himself,—the founder of an institution which, from the modest dimensions of an evening meeting of working men, has risen to be the entertainer of crowned heads; and now enumerates nearly 3,400 members of different grades.

"The directing the great sources of power in nature for the use and convenience of man," is a noble form of words. It is worthy of the pen of Bacon. It may well remain as the title-deed of the profession, for which we should venture to propose the motto, taken from the same classical English source,—"*Naturæ minister et interpres.*" And yet it is impossible to read the summary of the branches of science contemplated as exhausting this direction of the sources of power in nature fifty years ago, without becoming aware of how great has been the progress of science during that busy half-century. One item is omitted in Telford's charter which was not at the time unknown, and the failure to allude to which must have been mere oversight. In speaking of the drainage of cities and towns,—a matter which is, at the present time, of far more urgent necessity than was the case in 1828 (for the reason that the half-century has witnessed the increase of the population of the United Kingdom from twenty-four millions to thirty-three millions),—no mention is made in Telford's charter of the no less important works of drainage which have added nearly a million of acres to the areas of Lincolnshire and of Norfolk, producing rich crops of corn from localities formerly tenanted by the heron and the wild duck. Sir John Rennie, when looking back on the noble works of that nature which he had executed,—the Eau Brink Cut, the Norfolk Estuary Cut, the Nene outfall, the Witham improvement, and the Ancholme drainage,—pointed out that it was easy yet to add three new counties to the kingdom, by reclaiming lands from the estuaries of the Humber, the Firth, the Tay, the Clyde, the Solway, Morecambe Bay, and the Mersey; to the gain of six millions sterling worth of crops added to the produce of the country. In 1831, only three years after the date of the charter of the Institution, Telford was engaged, together with Rennie, in carrying out the Nene outfall. Indeed, the vigorous old man shortened his days by his neglect to change his clothes, or to take any precaution but,—if it may so be called,—that of sitting by the fire to evaporate, after a thorough drenching at Crab Hole, near Lynn. It must, therefore, have been a mere oversight, as before remarked, that words were omitted from the charter which would have foreshadowed the execution, not only of these noble English works, but of the drainage of Lago di Fucino, of the Haarlem Lake, and of the Zuyder Zee.

But if the steady development of this branch of the application of the sources of power in nature has produced such results within the half-century, and has so much more yet in store to reward the intelligent application of labour and of capital, there are other parts of the duty of the engineer which have been altogether transformed, or even newly called into being, since the 3rd of June, 1828. "The means of traffic," rightly referred to in the charter, have undergone such a revolution during the time over which we glance, that the advance made in the whole preceding period of the history of civilisation shrinks to almost nothing in comparison. And the art of transmitting intelligence, omitted from Telford's summary, has undergone a yet more magical and incalculable development. The only advance that could be made on the speed obtainable by her Majesty's well-appointed mails, on the Holyhead, the Shrewsbury, or the Devonport roads, eked out, perhaps, by the employment of a mounted messenger to and from a post town, was the clumsy and unreliable *semaphore*. Slow in its movements, taking minutes for the transmission of a word, an open secret to all who could read the few inartificial signals, useless by night, useless in a fog, the semaphore was our only telegraph in 1828. And it is not only by the discoveries of Wheatstone and his followers that an instantaneous mode of communication, with certitude and secrecy, which puts a girdle round the earth in less than the imagined forty minutes of Shakspeare, has been placed within our reach. We are only learning the A, B, C of the wonderful alphabet of the transmission, record, and intensification of sound. Among the objects which attracted most attention in the galleries of the Indian Museum were the telephone, phonograph, phonoscope, microphone, and other instruments connected with the electrical transmission of sounds, to which Professor Bell's marvellous discovery has given rise. It has taken ninety years to develop our application of artificial power to the purposes of locomotion, from the first self-moving land-carriage, made by Joseph Cuguot, a Frenchman, in 1769, to the actual condition of our railway service. "Puffing Billy" is now sixty-five years old. Stephenson's improved Killingworth engine, the first that was put upon springs, was completed in 1815. The competition between the Novelty, the Rocket, and the Sanspareil, which was the real birth of the passenger locomotive, was on October 1, 1829; a year and four months after the royal charter was obtained for the Institution of Civil Engineers. If we compare the slow progress made by the early inventors, men of pith and power as they were, with the rapid advance that the last few months has witnessed in the development of the wholly new method of electric transmission and reproduction of sound, we may form a very exalted idea of the improvement in the use of its powers that has been communicated to the human mind. As to the future progress of science, he would be more bold than wise who should propose a limit or a measure. And perhaps the most cheering part of the whole subject is the consideration that it is not only in its possessions, but in its functions, that the scientific mind has made so fast an advance in all the appliances of science, in manipulation of metals, in micrometric precision of observation, in ready application of mathematical analysis. The engineer of to-day has a full laboratory of tools and tables where those of the time of Telford had only appliances of the rudest nature. One of our great road-makers is said to have taken the levels of the lines he selected by means of holding up his shoe full of water, to obtain a horizontal line of sight! The electric telegraph opened a new chapter in the advance of science. Although it was for the purpose of obtaining a ready record of the letters intimated by the make and break of the electric current that the dash-and-dot system was devised, the application of it is one of such simplicity that its range is almost boundless. Thus the defenders of a besieged city or fortress can communicate with their friends outside, to a long distance, by flashing a mirror in the sun, or by the employment of a torch by night,—on the plan of the Morse code. Exactly the same might have been done in the time of Archimedes. But the mind was not then sufficiently awake to avail itself of a method at once so simple and so potent. This increase in the power of the mind to avail itself of the resources placed at its disposal by nature is a greater triumph of science than even the wonderful manipulation of those resources displayed in the construction of the locomotive, or the 100-ton turret-ship.

It would be a manifest exaggeration to say that it is exclusively the Institution of Civil Engineers that has to be thanked for that mighty stride in the education of mankind. But that it has had a share, and through its members at least a very important share, in this unexampled and bloodless victory, there can be no doubt. The men to whom we owe the steam-engine; its application to locomotion by land and by sea; the demand for a corresponding improvement in the art of signalling, which produced the electric telegraph, with its audible as well as with its visible methods of use; to whom we owe the extraordinary development of projectile power, and the corresponding increase in the power of resistance, are the men contemplated by the charter of 1828 under the unpretending style of "others of our living subjects." It was the object of the alchemist to put nature to the torture; he wearied himself, and made but slow progress, after all, in the effort. It has been the task of the engineer, since the days of Galileo, and more particularly since those of Watt, to put plain and straightforward questions to nature; and never have they been put altogether in vain.

If we glance at the proceedings of the Institution of Civil Engineers during the session that has just closed, we shall be able to form a not

* See *Builder*, p. 510, *ante*.

inadequate idea of the vast field over which scientific inquiry is now ranging. On the 13th of November, 1877, a valuable contribution was made to the history of civilisation, as affected by industrial progress, in a "Review of the Progress of Steam Shipping during the last Quarter of a Century," by Mr. Alfred Nott, M. Inst. C.E., of Liverpool. On the 11th December, a description, by Mr. W. J. Doherty, Assoc. Inst. C.E., was given of the cofferdams used at Dublin, Birkenhead, and Hull. The report of the council was received on the 18th of December, when Mr. J. F. Bateman, F.R.S., succeeded Mr. G. R. Stephenson in the chair. Mr. Bateman's inaugural address was delivered on the 15th of January, 1878. It alluded to the growth of the Institution, to the increase of railways, quarries, mines, iron-works, and canals, in the United Kingdom; to the education of the engineer both at home and abroad; to the telephone, which was not at that date described as accompanied by the three other instruments above referred to; and to the meteorological and geological conditions affecting the floods and river outfalls of England. On the 22nd of January the subject of recent improvements in dynamo-electric apparatus, a subject where the engineer joins hands with the chemist, was treated of by Dr. Higgs, Assoc. Inst. C.E., and Mr. Brittle, Assoc. Inst. C.E. Siemen's dynamo-electric machine and electric lamp were next described. The comparative cost of gas and electricity as a source of light was discussed; and the employment of the currents of magneto-electric machines for electrotyping and electroplating was stated to have long superseded the use of the voltaic current.

The evaporative power of locomotive boilers and the action of the blast-pipe formed the subject of a communication from Mr. J. A. Longridge, M. Inst. C.E., on the 12th of February; "Liquid Fuels" were discussed by Mr. H. Aydon on the 26th of February; on March 5th, the paper read was "On the Hooghly Floating Bridge," by Mr. B. Leslie, M. Inst. C.E.; "Railway Appliances at the Philadelphia Exhibition of 1876" were described by Major Douglas Galton, C.B., F.R.S., on the 12th of March. The striking fact gathered by the author from the Exhibition of Railway Cars at Philadelphia was, that while the comfort of railway travelling has been practically stationary in Europe for the last twenty-five years (he might have added "or retrograde," if he had recently travelled in a second-class carriage of the South-Eastern Railway Company) it had been rapidly developed in the United States to a standard above that of Europe.

On the 26th of March Mr. H. Davey, Assoc. Inst. C.E., contributed a paper on "Direct-acting, or Non-rotative Engines and Pumps." The Huelva Pier of the Rio Tinto Railway was described by Mr. Grosar, Assoc. Inst. C.E., on the 2nd of April. Mr. Ed. Bazalgette, Assoc. Inst. C.E., gave a paper on "The Embankments of the River Thames," on the 9th of April. Three bridges on the Punjab Northern State Railway were described by three different authors on the 30th of April. "The Construction of Steam Boilers adapted for very High Pressures" was brought forward by Mr. J. F. Stannery on the 7th of May. "The Design generally of Iron Bridges of very large Spans for Railway Traffic," by Mr. T. C. Clarke, M. Inst. C.E., of Philadelphia, formed the subject of discussion on the two concluding evenings of the session.

It is not only by the preparation and discussion of papers by members of their own body that the Civil Engineers have advanced the objects contemplated by the charter of incorporation during the past year; their admirably-constructed theatre has been freely lent for the proceedings of the Mechanical Engineers, and other scientific gatherings. Of the annual meeting of the Mechanical Engineers we gave a report at the time. The reflection can hardly fail to suggest itself to the mind that the division of the subjects of discussion was hardly in accordance with the special titles of the separate bodies. The appliances for raising sunken vessels, which were described in most instructive detail at the Mechanical meeting, form an integral part of civil engineering. The same may be said of the construction of docks, and the relative cost of the light and heavy traffic on railways; the discussion of which attracted so much attention on the 11th and 12th of April last. It may be permitted to hope that the juxtaposition into which two such eminently practical and useful associations as the Civil and Mechanical Engineers are thus drawn, by the courtesy of the council of the former, and the enlightened and active exertions of the two able secretaries, to whom the two institutions owe so much, may lead to some organic arrangement, which may spare valuable time, and give each body a yet higher status by association with its fellow.

There is no doubt that the engineers of the United Kingdom, a vast body of men under all the branches,—civil, mechanical, naval, telegraphic, and operative (or, as they call themselves, amalgamated)—of the profession would take a far higher position, both as public bodies and as individuals, than is actually the case, if they could overcome the old-fashioned English dislike to organisation. In all other civilised countries organisation regulates the position of the engineer to his great and manifest advantage. It would have been scarcely possible for that great misfortune to the country as well as to the profession,—the overloading the railway share-market by the construction of so many "contractors' lines,"—to have occurred, had the profession been properly organised. Engineers would then have shunned to take the position of the servants of contractors,—an abandonment of the original modest pride of such men as Robert Stephenson and his immediate pupils which has been attended with disastrous results. No engineer would, in that case, have lain under the stigma, whether deserved or otherwise, of having taken large commissions or large presents from his contractors. Charges of that nature, if actually published, would have been investigated by any court or tribunal that represented the profession, and either the stigma would have been removed, or the subject of it, if it proved to be deserved, would have been rendered incapable of a repetition of the offence. By raising the tone of the profession the confidence of the public would be secured, and in lieu of the large sums of English money which have evaporated in foreign loans, we might have had the full employment of a large body of men, who would have struck new fountains of wealth, and by works of drainage, of irrigation, and of reclamation, added largely, not only to the produce, but to the actual solid acreage of the United Kindom.

The example recently given, in the discussion of an engineering subject in another theatre, of the advantage of proceeding by definite resolutions, and of thus not only publishing opinions, but adding to the dominions of positive science, might, no doubt, be advantageously followed by the different sections of the great body of engineers. The junior chamber, so to speak,—we mean the mechanical engineers,—have also set a very excellent example to their elder brethren by the freedom with which the debates are open, not only to the reporters of the press, but to intelligent visitors, who are anxious to take a part therein. Something of the nature of organisation can hardly fail to ensue if it come to be considered that any explanation or discussion which is not followed by a division, or, at least, by a vote, is to a great extent a lost sitting.

Above all, the Institution of Civil Engineers would at the present time but increase its claims on the respect and admiration of the public, by giving careful attention to those expressions of its charter which refer to traffic both for internal and external trade,—especially with reference to internal navigation. The examples of France and of Belgium cannot be too distinctly held up before the eyes of the English public. In France the development of inland navigation has gone on side by side with that of railways, to the great enrichment of the country as well as of the railway shareholders, ten per cent. dividends accompanying the concurrence of canals. In Belgium, where the tariffs have been lowered on the railways of the State, and every measure has been adopted (as has been the case in certain parts of England) to strangle the canal traffic, practical bankruptcy is the result. The statistics of the mineral trunk and non-mineral trunk lines in England point in the same direction. On the other hand, the important discoveries made by no less hard-headed a man than Fairbairn, in 1831, remain where he left them. So late as 1853 Sir W. Fairbairn recalls the fact that "although at speeds of from five to eight miles per hour the resistance to vessels drawn through narrow channels increased more rapidly than the squares of the speed; at from eight to fourteen miles,—when the vessel rose to the surface and *skimmed* upon the water,—the force of the resistance was so greatly diminished as to reduce the obstruction to the vessel's progress continually under that ratio." When we see, not only the practice in France, but the 18 per cent. dividends of such undertakings as the Leeds and Liverpool Canal, we cannot but suggest that this question of internal navigation,—a mode of communication to which we owed so great a part of our material progress before 1829,—is one to which the attention of the Institution of Civil Engineers may be called with admirable results in the session of 1878-1879.

MURAL DECORATION:

ARCHITECTS AND PAINTERS.

THE question of the relative position of architect and painter, in regard to the pictorial decoration of buildings, has always been rather a vexed one, and received some consideration and discussion in connexion with Mr. Armitage's paper at the opening meeting of the Conference on Monday week. The result of the discussion (printed in the *Builder* of last week) was rather odd in some respects. Mr. Armitage, as will be seen by our report of his paper, gave as one of the reasons for failure in the attempt to combine mural decoration with architecture the frequent want of proper understanding between the architect and the painter, intimating pretty clearly that the architect generally did not give sufficient consideration beforehand to the requirements of the painter as to lighting and wall-space, and admitting at the same time that the painter was commonly somewhat too desirous of exercising his own individual pleasure and judgment irrespective of the general scheme of the architect. This we take to be very much the truth in the main. But the tone of the discussion was mostly quite the other way: and certainly it was refreshing to find architects professing their entire humility and subordination to the superior genius of the painter, and painters gracefully admitting that the architect was necessarily the presiding genius in all association of architecture with the other arts. It would be still more refreshing, no doubt, if we found these two principles more frequently acted upon in practice. We say advisedly, the two principles, for they are both correct, and not contradictory, if rightly regarded.

The position laid down by Mr. Aitchison, who contributed one of the two really practical and pointed speeches to the discussion of the subject, that architecture was an entirely subordinate art in its interest to that of painting,—that wherever the representation of the human figure and human life was concerned, there the artistic interest was highest,—is undoubtedly true. In spite of the platitudes, many and grievous, which have been uttered by architects and architectural writers, extolling architecture as the parent of all the arts, and so forth, it must be obvious that the highest conceptions of human genius and human feeling cannot be displayed in walls and towers and window tracery, in plan and "skyline." It is a foolish and mischievous criticism which asserts the contrary. Architecture has, however, very large interests apart from its artistic side, in its connexion with the history of the past and the habits and needs of the present, in the number of practical and scientific problems interwoven with it, and in the important influence which it has upon the aspect of great cities and on the general beauty or ugliness of the framework of our daily life. And it was, perhaps, a pity that Mr. Aitchison did not touch upon this side of the interest of architecture (which he would not be likely to forget or overlook), instead of rather chilling the sympathies of his audience by so pitilessly handing down architecture to "the lowest room" with no extenuating circumstances. Still it is sometimes well to have one side of a subject put in an uncompromising manner; it is more likely to lead people to think, or at least to strike their attention, than a more cautious expression would be. The other side, however, of Mr. Aitchison's view of the matter is this: that while architecture cannot alone compete with sculpture and painting, and while any addition of decorative painting to architecture is the addition of a new and higher interest such as the architect alone cannot hope to excite, there does rest with the architect the very responsible and important task, too often neglected, of forming or planning the whole architectural and decorative scheme from the commencement, and indicating the general idea, the details of which the painter is to carry out to their perfection. To put it more plainly, what we mean is this: that where it is intended that a building should be ultimately decorated

with mural painting, the whole scheme should be conceived from the first, and the architectural details should harmonise with and, where possible, be suggestive of the pictorial subjects which are to form the crown of the whole. And it appears to us that it is directly the province of the architect rather than of the painter to conceive or invent the idea of the whole result, though he cannot carry it out himself; to say that here there shall be a series of paintings illustrating such a subject in connexion with the objects or associations of the building; there we shall have a sculptured frieze suggesting a comment on the main purport of the illustrations; and so on. He ought, if possible, to know what painters and sculptors will undertake the work, before the building is commenced; to consult with them as to the space, the lighting, the number of compartments required; to ascertain what their method of treatment would be, and (if it appears necessary) to accommodate or modify his architectural scheme to enable them the better to work with him. But with these limitations we do think that the architect may fairly lay claim to be the initiating mind of the whole scheme of combined architectural and mural decoration, however humbly he may think of his own art in detail in comparison with that of the painter.

Mr. Street would have gone further than this, and seemed rather inclined to claim for the architect the right to drill the painter into proper obedience in regard to the style and treatment of decorative pictures. He was so far in keeping with the general feeling of the meeting in regard to the painters, that he conceived it was their business to say what subjects could or could not be treated in particular portions of a building,—in fact, to give the idea of the whole thing. But the painter having given the idea, he would then subject him somewhat to architectural leading-strings, and refuse to have anything to do with him unless he would paint in the proper style for architectural decoration. The justice of this, of course, depends very much on what we consider to be the real requirements of mural decoration. That it is not to be pictorial in the ordinary sense,—not to make any attempt at "chiaroscuro" (it was quite pleasant to hear this old-fashioned piece of artistic "slang" brought out again!), everybody is pretty well agreed, and Mr. Armitage did not omit to urge this in his paper. But Mr. Street's comments really led to the conclusion that the only good or desirable wall-painting was that which was conceived in a Mediæval spirit. The list of painters whom he named as having executed successful works in mural decoration must have amused those who know anything of art politics and parties in London, so completely did it infer that in one school alone was any good to be found. We do not think new life and interest will be given to modern architecture by the addition of Mr. Spencer Stanhope's eccentricities to the walls of our buildings, at all events, whatever may be said for one or two stronger though very abnormal and artificial painters who were named. What is mainly wanted in mural decoration is a generally good effect of colour (unless this is obtained from other sources of decoration), and fine but not too elaborate or realistic form. We have before pointed out that in regard to general style a remarkably fine and suitable precedent is to be found in the outline designs of Flaxman, which possess all the qualities requisite in modern mural decoration (colour, of course, excepted); which are Classic in style without being merely imitative in sentiment, presenting, in fact, modern feeling in the language of Greek art; and which represent the *juste milieu* between realism on the one hand and formal stiffness and severity on the other hand. This *juste milieu* is what is required in such designs; a sufficient freedom and power of drawing to satisfy the requirements of modern criticism, which refuses to be fed on Mediævalisms; a sufficient severity of style to harmonise with architectural design and with the monumental character we demand from pictorial designs executed in imperishable material, and forming part of a permanent structure. Mural paintings based on such a style as that of Flaxman would harmonise equally with either a Greek or a Gothic building, if the building were good in itself. To invent Mediæval painting to suit a Mediæval style of building is simply to make a dead art instead of a living one.

The importance of the practical point brought forward by Mr. Street in regard to the difficulty of getting the highest class of art applied to small buildings in out-of-the-way places (where above all it is, perhaps, desirable) will be readily perceived; and the suggestion that a kind of work should be adopted capable of being executed in the artist's studio in town, and reproduced or set up elsewhere independently of his personal assistance, although not new, is well worth consideration.* In one of the speaker's conclusions on Mr. Armitage's paper there is, however, a fallacy. He objected entirely to the idea that mural paintings were injured by juxtaposition with stained glass, and instanced buildings where there were frescoes in conjunction with strongly-coloured stained glass; but in pointing out the reason for the success, the employment of very low tones in the frescoes, so as to suggest no competition with the windows, he practically confirmed Mr. Armitage's remark. It merely comes to this,—that it is impossible to employ reflected colour and transmitted colour on equal terms in the same decorative scheme. If there is decided colour in the windows, the wall-paintings cannot possibly compete with it; they must occupy a subordinate position; and a painter who is at all dependent on the colour-design of his mural paintings of course feels this, and feels that his art is thrown away in such a position. Mosaic is the only wall-decoration that can stand against stained glass; and even then we opine that one or the other must lead in regard to colour; they can hardly blend; the two methods of lighting the colour cause it to affect the eye so differently.

It is matter for congratulation that the new class of Honorary Associates of the Institute seem inclined to render their adherence to its ranks something more than nominal, and we hope others will follow the agreeable precedent thus set by Mr. Armitage, whose paper was one peculiarly fitted to bring architects and painters together on common ground, since it dealt with the subject from an eminently practical and not from a merely artistic point of view. It is, perhaps, characteristic of this practical tendency of the paper and the discussion, that we had none of the usual enthusiastic prophecies which turn up so often when mural painting is mentioned, as if the adoption of that method of art-production was sufficient in itself at once to insure a revival of artistic power and genius equal to what existed in the greatest age of the art of painting,—as if the mere painting in one medium instead of another would create genius and give great ideas and a great style to those previously destitute of such gifts. It is well to be hopeful, and we have no doubt, and have always asserted, that a more extended adoption of mural painting would do at least this,—it would raise and foster a more extended public interest in art, and desire for artistic illustration, than is now the case, when pictures are confined to special galleries entered by only a small section of the people. But there is no conclusion to be necessarily drawn that this state of feeling would produce great (or greater) artists, unless indirectly by fostering a greater demand for good art, which would lead more men of intellect to turn their attention to it. If, indeed, mural painting were to be practised under the feeling advocated by Mr. Street, that the painter should be checked from "revelling too much in the modern power of drawing," the result would be to give a retrograde rather than a progressive movement to the painters' art. The painters might very well reply that it was part of their mission to prevent the architect from revelling too much in mere antiquarianism and the affectation of stiff and semi-barbaric style, the danger which seems always to beset mural painters as well as designers of stained-glass windows. And again we say, as an antidote to this, turn to such art as Flaxman's, and take that as a *point de départ*, working out further the combination which he suggested of Greek artistic feeling with modern sentiment, and there will be far more chance of doing something that will have life and interest in it for modern times than by going back to Constantinople and Ravenna, to an art combining imperfect execution with superstitious sentiment.

London Bridge.—The Corporation Bill, seeking powers to widen London Bridge, at the cost of 75,000*l.*, has been withdrawn.

* Here, again, we observe that the suggestion as to having designs mainly in outline, which are more easily capable of repetition or reproduction by another hand than colour designs, points to just the style of production which Flaxman practised with such beautiful results.

SANITATION AT THE PARIS EXHIBITION.

In the great concourse of human industry and invention now evoking the attention of all Europe, sanitary science holds here and there a prominent place, though it has been strangely neglected in some sections. We cannot at present pretend to do more than merely introduce the subject, for many of the most important constructions are not yet completed; notably the new system of cottage hospitals, extensively adopted in the French army, and which are built solely for the purpose of realising practically the newest discoveries in hygiene. Again, it was only on Friday, the 31st ult., that the annexe devoted to anthropology was opened, and on Sunday the workmen's exhibition was inaugurated. In both of these there are many things of special interest from an architectural, artistic, and sanitary point of view. The former embraces all vital statistics, and possesses a rich collection of tables demonstrating the connexion between meteorological changes and the fluctuation in the rate of mortality in different districts and countries. This and general climatic influences, and the nature of the soil, should be taken into consideration in the construction of houses and the selection of dwellings; and might explain away many a complaint unjustly levied against the architect, the builder, or the engineer. Without discussing all the grave problems propounded in this section of the Exhibition, it may be remarked, in passing, that the chief result will be the revelation that Portugal possesses arrow-points, ornamental stones, &c., perhaps in a greater profusion and, in any case, as handsomely worked and as well preserved as those which anthropologists have discovered in Ireland. Further, it will be seen by some admirable specimens to what extent the art of carving bone was practised at the epoch of the glaciers, and that the polished stone period varied very considerably, not only in different countries, but in different districts.

Quitting these traces of pre-historic industry to investigate the work of our day, we cannot say that the Exhibition afforded us unmixed pleasure. In group 3, class 20, we found, for instance, some French hardware that did not betoken any more knowledge on sanitary matters than the relics of the age of bronze exposed in the Anthropological Museum. There were tesselated stoves which had nothing new about them and could not help to solve the vexed question of the ventilation they so gravely impair. The Armentières potteries display drain-pipes that are about as common and as inefficacious as it is possible to imagine. They are totally innocent of any attempt to check the ascending tendency of sewer gas, and there is no sign of any sort of communication with a ventilating-shaft. It is difficult to conceive why these things were exhibited at all. The manufactures from the departments of the Oise and the Herault are not preferable; and the Haute Loire presents the public with old-fashioned and discarded filters such as were used in the time of Louis Philippe. The hardware cooking utensils, saucepans, frying-pans, coffee-pots, &c., were more interesting; and, in these days of gas stoves, might in many instances be used with advantage in English kitchens. These objects are all exhibited in an annexe situated between the main building and the École Militaire.

Close at hand there is a charming Russian house, where Jablockkoff's process of lighting by electricity is to be exhibited. The best exhibition, however, of this process is that given every evening in the streets of Paris. Certainly the Rue de l'Opéra, the Place de l'Opéra, the Corps Législatif, and the Arc de Triomphe, illuminated by electricity, are among the most marvellous and beautiful sights Paris has to offer to its visitors. The vivid and yet pale moonlight glow of the burning carbon produces a fairy-like effect which is most difficult to reconcile with everyday life. This new method of illuminating involves a sanitary question of great importance. The injurious emanations of gas, its rapid consumption of the oxygen we should breathe, renders it in many circumstances highly injurious to health. The difficulty of supplying a theatre with sufficient pure air is greatly increased by the extensive consumption of gas within its walls. Dr. Angus Smith calculates that the burning of two candles produces as much carbonic acid as the breathing of one man. But what will be the result of

THE PARIS EXHIBITION: THE SÈVRES STAND IN THE EXHIBITION BUILDING, CHAMP DE MARS.

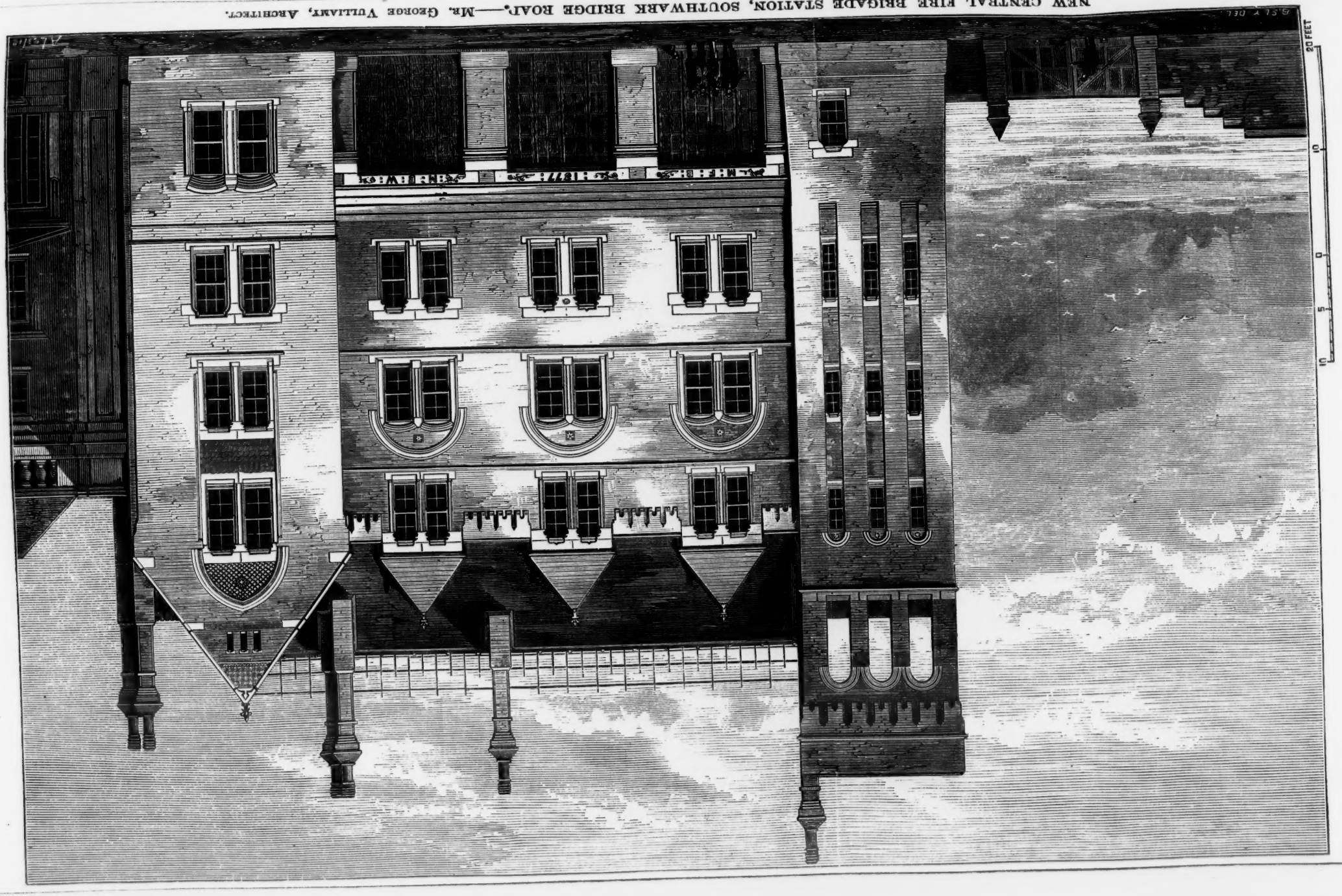
the illumination of public buildings, theatres, &c., by electricity? We regret to say that, in answer to inquiries, it was stated that no experiments have been made for the purpose of elucidating this important phase of the question, and the Société Générale d'Électricité would do well to take it into consideration. There is no doubt that electricity will offer many advantages over gas from the hygienic point of view. The Russian pavilion, where this method will be explained, is also remarkable for its decorations in pure Russian style. The only difference is that the wood-carving is merely varnished and not painted in the gaudy colours which find so much favour in Russia. This structure is so remarkable that nearly every day a new purchaser presents himself. The design of the wood fretwork is the same as that found ornamenting the petticoats and the household linen, of the peasantry, and the silk embroidery of the wealthier classes.

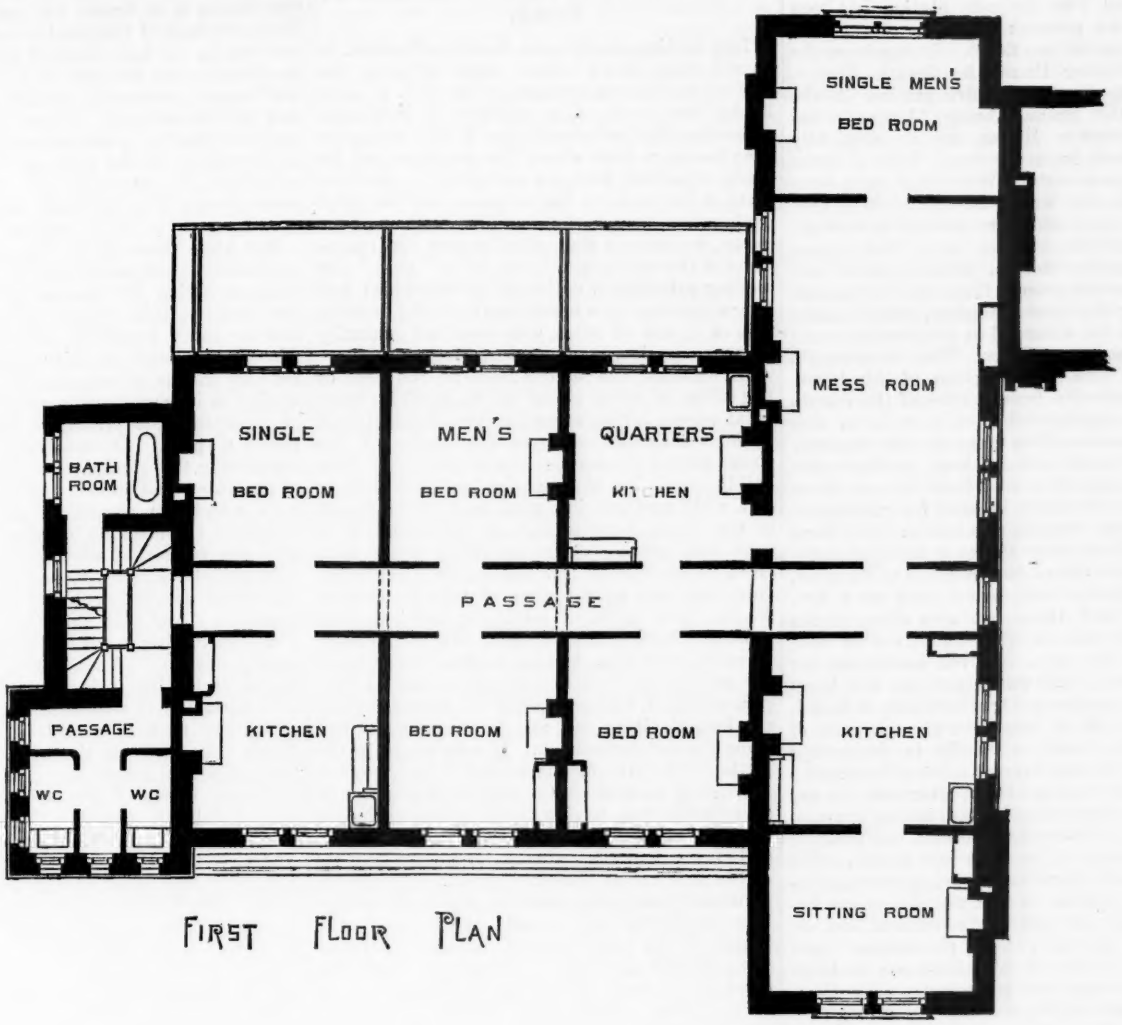
Continuing our way round the outskirts of the buildings, we passed many other constructions of equal interest, and found in the Dutch agricultural annexe a curious model of a farm made by the pupils of the École des Métiers de Cromingue. From a wall, 5 ft. high, a gigantic roof, reaching to an elevation of perhaps 30 ft., covers the principal building. On one side, under this broad shelter, are carts, sledges, agricultural implements, and pig or sheep styes; on the other the stabling, and over it the hay-lofts. At the end of this barn-like structure, and opening into it by a door, is the farmer's house, in which two of the bed-rooms are devoid of fireplaces, and are abominally ventilated. The constructors of this farm have still much to learn before nearing the ideal.

The Belgian annexe comes next, and this is indeed a remarkable exhibition, where many hours of useful study might be spent. All that relates to education and the construction of schools will be found here; and we must return to this annexe before we can do it full justice. Here will be seen a model of a class-room of M. le Belot's celebrated school. The walls are surrounded by mottoes, proclaiming his principles of education; and further the managing committee invites all inventors to send models that may serve for the practical education of the pupils. The committee organises geographical excursions; it has a large collection of specimens for teaching all the natural sciences, &c. Efforts are made to develope physical strength simultaneously with the acquisition of learning; and we are told that,—"This school is secular, believing that the father should direct the religious instruction of his child. The schoolmaster should only inculcate the spirit of tolerance and the sentiment of respect for all sincere convictions." The education given is of a purely practical description, and we need scarcely remark that sanitary matters are not neglected. There are drawings illustrating the artificial means of ventilation employed to keep the air of the class-rooms pure; a shaft and furnace have been built expressly for this purpose. Apart from the lessons given within the walls, innumerable excursions are organised for the same purpose. Thus we have before us an account given of the examination by the pupils of the canalisation of the Senne and the Brussels sewers. On other occasions the pupils were taken to visit the docks at Antwerp; or to examine large printing-works and a paper-mill. Woollen factories, breweries, quarries, brick-fields, the potteries, etc., have all formed the subject of these educational excursions; and it will be readily understood how this form of instruction must interest young pupils, and tend to develope any latent faculty which might otherwise have remained dormant within the dull precincts of the old-fashioned schoolroom.

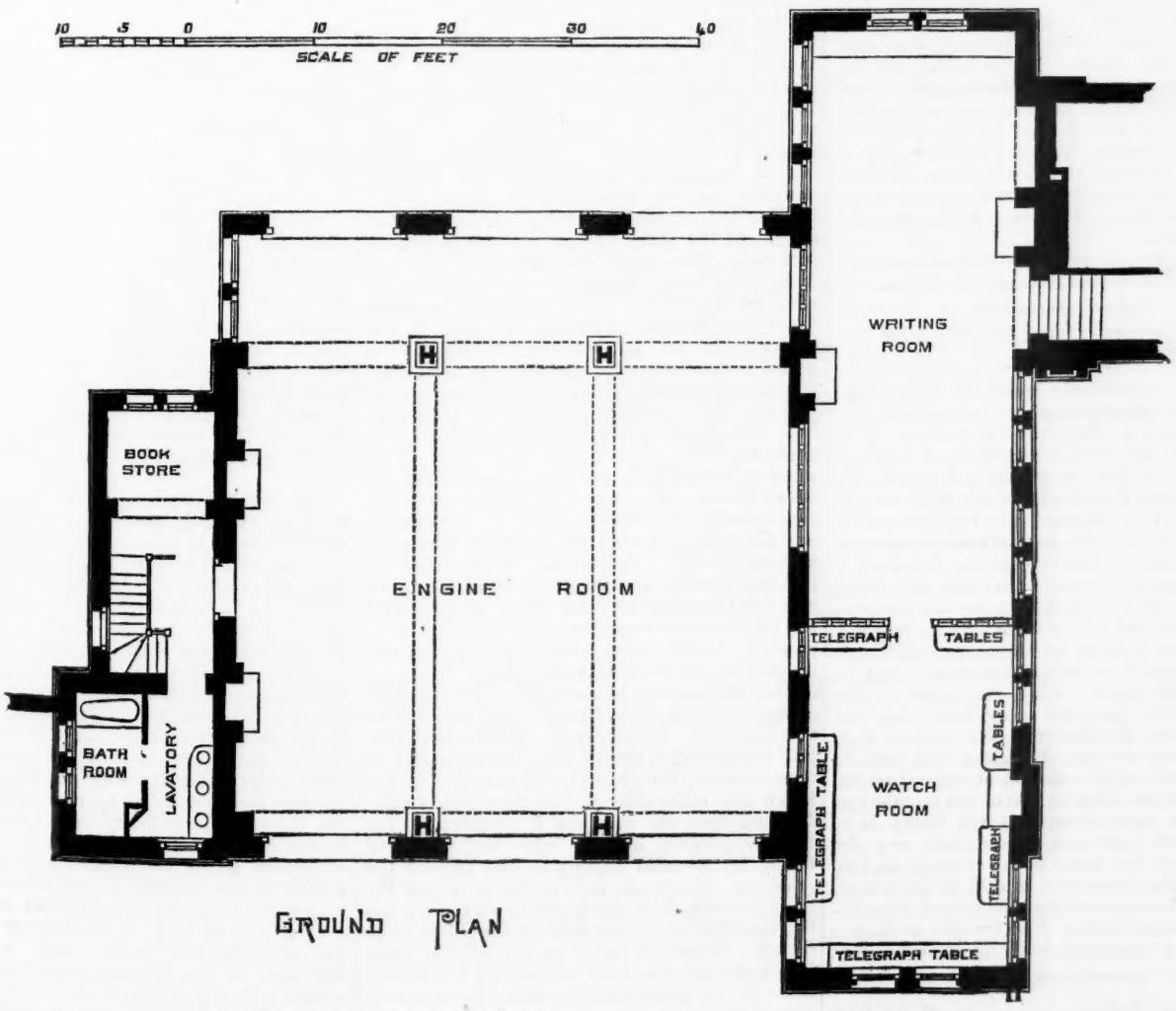
We add to the illustrations of the International Exhibition, which early appeared in our pages, a view of the building erected in the vestibule for the display of the works contributed from Sèvres, which is certainly superior to many of the other architectural *pièces de circonstance* which are profusely scattered about. We have other illustrations in progress.

NEW CENTRAL FIRE BRIGADE STATION, SOUTHWARK BRIDGE ROAD.—Mr. George Vulliamy, Architect.





FIRST FLOOR PLAN



GROUND PLAN

CENTRAL FIRE BRIGADE STATION, SOUTHWARK BRIDGE ROAD.

NEW CENTRAL FIRE BRIGADE STATION.

THE Central Fire Brigade Station has been opened, and we give an elevation of the new part and plans of two floors. It stands on the site of Winchester House, Southwark Bridge-road, and is the largest fire station in the metropolis, the ground being 1¾ acre in extent. Winchester House, as it originally stood, set back from the road, formed three sides of a quadrangle. What has been done principally in the way of new building is that a block has been added to each of the wings. This new addition on the front line represents the engine station, writing room, and watch room on the ground floor, which is capable of containing the largest engines, and the three stories above are intended as quarters for some of the men and the officers. There is a watch-tower 78 ft. high springing out of this block, with communication from the top of the watch-room by a speaking-tube. Up aloft on this tower, and commanding a good view in every direction, a watch will be kept, so that a fire illumination anywhere will itself be an alarm that will put everything in order for turning out when the exact intelligence comes. The front portion of Winchester House is devoted to the use of Captain Shaw, the frontage to the road, where the garden was, being used as a fire-escape yard, and the other two sides of the edifice, looking into the quadrangle, are for more quarters for the men, and the basements for education, bath, and washing-rooms and hose-shops. This quadrangular courtyard, a broad, open space, will be used for the purpose of exercising the men, especially in fire-escape practice. There is a dummy front of a house on one side, with window-like apertures at the top opening on to the roof. The roofs are so arranged with a level platform that the men can practise running about at a considerable height. The other block added contains stabling accommodation for the horses, so that the stables are immediately opposite the engine-station, and no time will be lost in getting the horses "put-to." At the rear of all these are a large smithy, workshops, and storerooms, while there are several outbuildings, including a long fire-escape shed. The buildings are of brick, dressed with stone. The alterations and additions have all been effected within twelve months, the contractors being Messrs. Hook & Oldrey, of Kensal New Town, and the architect is Mr. G. Vulliamy, assisted by Mr. Mott. The ground, with the buildings upon it, cost the Metropolitan Board of Works 35,000*l.*, which was increased to about 38,000*l.* by the purchase of certain leaseholds and trade interests. The cost of the buildings is 32,000*l.*, making the total about 70,000*l.* There is accommodation for 52 firemen (28 married and 24 single), 14 horses, 16 engines, and 20 fire-escapes.

As already mentioned, our illustrations relate only to the new portion, the engine station.

THE LETTING OF DRURY-LANE THEATRE.

As Mr. Chatterton's lease of Drury-lane Theatre will terminate about midsummer, the directors have publicly invited tenders for a new lease of the establishment, for a term, as is understood, of five years, and it is stated that there are several applicants in the field, rumour giving it out that, amongst the tenders sent in, more than one is on the part of certain members of the aristocracy. Mr. Chatterton, it is said, is desirous of again becoming the lessee, and, along with others, it is known that he has made an offer for a renewal of the lease. We understand, however, that it is by no means certain that it will be accepted, as the directors are said to have resolved upon letting the house to the highest bidder, provided other conditions and references are satisfactory. We believe that, whoever may become the lessee will have to incur a considerable outlay in structural alterations and improvements, one of the stipulations in the new lease being that the lessee is to expend about 1,200*l.* on a new stage, and also to redecorate the house both externally and internally. Mr. Chatterton is said to have made an offer to bear a moiety of the cost of these improvements and works. The time for sending in tenders for a lease of the building expires to-day.

Hastings Baths.—The whole of the iron-work for this building, of which we gave illustrations in our last, was supplied by Messrs. Matthew Shaw & Co.

MR. KIRKALDY'S TESTING MACHINE AT WORK.

THE testing-machine in Southwark-street is an old story now; but so much interest was excited in it on the occasion of the visit to it, on Friday last week, of a number of architects attending the Conference, that it may be opportune to say a little about the machine and its work, especially because, owing to the crowded state of the room on the occasion, and the brief explanation, necessarily inaudible to some of the party, we suspect that all who saw the operations of the morning did not quite "grip" the leading principle of action of the machine; and to readers who have never seen it a brief description of it, and of what was observed generally on that occasion, may be interesting.

On entering the testing-room at the back of the office, a room about 40 ft. to 45 ft. long, what we see is this, as well as it can be described without diagrams:—Down the centre of the room runs a ponderous iron erection, we may call it, consisting of a massive bed-plate 3 ft. or 4 ft. wide, and running great part of the length of the room, terminating at either end in a solid iron casting or frame rising about 5 ft. from either side of the bed-frame. Extending from one end to the other of this framework we see three pairs of mighty cylindrical steel rods, varying from about 9 in. to 6 in. in diameter, three on each side, leaving a clear space along the middle. Of these the uppermost and thickest pair are fixed, and are merely for connecting the castings at either end, and forming a great rail tying the whole together. If now we go to the farther end of the machine we find that, beyond the end of it, there is the horizontal cylinder of a hydraulic ram, having the solid casting for its base of operations, acting with its back to the end of the main framework, and thrusting its piston outward at the further end. The piston thrusts against a massive iron crosshead travelling on wheels laid on rails at either side the length of the piston-stroke, which is 3 ft. or 4 ft., though in practice the piston is seldom required to move more than a fraction of an inch in one experiment. To this cross-head are attached the second set of cylindrical rods, which we will call the tension-rods, and which we see running back on each side of the machine below, and a little within the line of the main constructional rods first mentioned. For the greater part of their length the tension-rods are tapped with a screw thread, and they run through a very heavy transverse travelling-frame of solid iron, which, by means of large cog-wheels acting on the screw, can be moved backwards and forwards to different positions on the tension-rods so as to adjust itself to the length of the object to be operated upon. Of the third pair of rods we will speak just now. This transverse travelling-frame is what immediately acts, in most cases, upon the material to be tested. Between the travelling-frame and the ram end of the machine we see, on the bed-frame and between the tension-rods, a smaller transverse casting facing the travelling-frame, and apparently fixed; for the present we will consider it as fixed, and call it the thrusting-bed. Now suppose it is desired to subject something to compression or thrusting strain, say a piece of timber 5 ft. in length: the travelling-frame is adjusted by means of the screw on the tension-rods, till there is just 5 ft. between it and the thrusting-bed; the piece of timber to be tested is then dropped into its place with its two ends resting in seats in the travelling-frame and the thrusting-bed, and lying parallel with the length of the machine; the water is then pumped into the ram, which imperceptibly but irresistibly draws the travelling-frame, by means of the tension-rods, towards the thrusting-bed, compressing the timber lengthways between the two surfaces. If, however, it is desired to subject something, a bar of iron for instance, to a *tension* strain, the object to be operated is put in on the other side of the travelling frame, furthest from the ram, and is attached to the travelling-frame, and its other end anchored firmly in the solid casting at the end of the machine. When the ram is put in action the tension-rods pull on the traveller as before, and the traveller in its turn pulls on the object to be tested. Thus the same motion of the same hydraulic ram does both tension and compression: if the object is to be tested by compression, it is put in *between* the traveller and the ram and crushed by being pulled up against the thrusting-bed; if it is to be tested by tension it is put in on the further side of the traveller from the ram, and attached to it, and when the ram moves it is drawn out and torn asunder. The advantage of this consists not only in making one ram do for both kinds of trial, but in using the tension-rods, the part on which the heaviest work comes, always in tension, in the strongest way for the material. The only portions of the machine which are in compression in either case are the piston of the ram and the heavy fixed cylindrical rods connecting the two ends of the frame, and which distribute the recoil force of the ram over the whole machine.

But while there is all this provision for the application of tremendous force in testing, what is the provision for measuring and registering the force applied? That is the most important and the most beautiful point in the machine, wherein its most peculiar speciality consists; for the means of mensuration of the strain applied is intimately connected with the method of applying the strain, of which, indeed, it forms a part. In examining the means of registering the strain, we now come to the use of the third and lowest pair of great circular rods which we described as traversing the length of the machine in parallel lines. These rods are connected with the piece which we have called the thrusting-bed, against which the end of the material subjected to thrusting strain impinges. And this thrusting-bed, though we were considering it, *pro tem.* as a fixed point, is in reality not so. When thrust against in the course of testing, it is retained in its place by the lowest pair of parallel rods above mentioned, which are then in a state of violent tension. These rods pull on the heel of a ponderous horizontal iron lever placed at right angles to the main frame of the machine, and turning upon a fulcrum close to the line of the pull, leaving a long leverage on the other side of the centre, so that the pull upon it near the fulcrum is greatly multiplied at the further end of the lever. This further end in its turn pulls (again at right angles) on two lighter steel rods, which lastly pull on the heel of a steelyard rising and falling between them, and provided with sliding weights and a graduated scale on the usual principle. When, therefore, a piece of timber, for instance, is tested by thrusting strain, the thrusting-bed against which it impinges pulls, by means of its connecting-rods, on the heel of the horizontal lever, the lever (through its steel connecting-rods) pulls on the heel of the steelyard, the strain being thus conveyed round two right angles, and the ultimate result is to raise the tip of the steelyard. The sliding weight on the latter is then moved forward, till it brings the steelyard level again, the hydraulic pressure is increased till the steelyard is again raised, when the sliding weight is moved further on, till the point is reached at which the specimen under test crushes, when (if the crush is sudden) the steelyard immediately drops through the sudden relaxing of the pull being felt all round through the various connexions. The strain that has been reached is read off by the man at the steelyard with each shift of the sliding weight. When a specimen is to be tested for tensile strain, the difference is merely that the pull is made direct upon the heel of the horizontal iron lever, without troubling the thrusting-bed and its connecting-rods.

The peculiar advantage of this method of applying strain is that the strain is made not against a dead resistance, but against a system of levers which have a certain *give* in them, so that any sudden jar or shock which would vitiate the fairness of the test is avoided. The elasticity of the material tested is allowed its full operation, and when a material possessing elasticity is under test, the steelyard is seen vibrating up and down with every vibration of the material under test, which renders the strain momentarily greater or less. But another important advantage is that the possibility of error in the results is nearly eliminated. Every one who has been called upon to watch tests by the light of the ordinary pressure-gauge of a hydraulic ram must have been troubled with scepticism as to the reliability of this way of getting at the results,—a scepticism perfectly reasonable when we consider that so ordinary a complaint as rust in the piston or matrix of the hydraulic ram would make a material difference in the pressure registered on the gauge, so that a testing ram in such a condition would always be registering in favour of the material tested. But in Mr. Kirkaldy's machine the measure of the test is the raising of a certain weight which can never alter and can

always be measured with certainty; any clogging in the action of the hydraulic ram has no effect whatever on the pressure or the register of it, and the only possible element of error is in friction at the fulcrums of the levers through which the pressure passes to the steelyard. The possibility of this is reduced to a minimum by causing all the centres to bear upon "knife-edges" of steel, so that until these get appreciably blunted by use the friction on centres is practically hardly worth taking account of. This reliability of the result was obviously not appreciated by all those present on the occasion we are referring to, as one gentleman asked rather pointedly about the effect of variations of temperature on the results, from the expansion or contraction of so long a series of metal connexions; a matter which has absolutely nothing to do with the result, any more than it has with the correctness of a pair of scales. The machine is, in fact, a scale in which pressure is *weighed*, and the friction on centres is the only vitiating influence, and that, as we have seen, is reduced to an inappreciable element.

One or two other details in the working of the machine may be mentioned here. When it is desired to test something requiring a lower pressure than any which the steelyard registers, the steelyard is counter-balanced; it has a second arm on the opposite side of its fulcrum, which can be weighted so as to cancel a certain amount of the weight registered on the steelyard scale. On the other hand, if an extra heavy pressure is required, the tip of the steelyard can be immediately and readily connected with the heel of a second steelyard working above it in the same plane, but hung the reverse way, by which the pressure is at once multiplied in a great ratio. There is also a special provision for registering the compression or tension of the object under each stage of pressure. The person overlooking the test sits on a bench placed across the trough of the machine between the parallel rods, immediately overlooking the specimen, while close under his eye is a circular horizontal dial-plate, with an indicator working on it, like the finger of a clock, which is connected with the moving part of the machine so as to indicate any variation in the length of the specimen by a circular movement of the finger on the dial; the motion being greatly multiplied on the outer edge of the dial, where the graduated scale is, so that even a movement of $\frac{1}{1000}$ of an inch can be read on the dial-plate by the eye. As the man at the steelyard reads off each increase of pressure, the head operator notes down the tension or compression on the dial,—so much compression at a pressure of so much per square inch; and when the pressure gets high he also glances at the test specimen itself to see how it is behaving, and by this means and the reading of the dial combined, he is able to stop the operation at the critical moment when the material, if tried further, might possibly give way suddenly and fly; this has happened once or twice, but without any injury, fortunately, being done to any one. On the occasion of the Conference visit, the first specimen put under test was a cylinder of English oak, 25 in. sectional area and 4 ft. 2 in. long. To those who had not seen the operation before it must have been really curious to see the gradual action of the pressure exerted endways on this very solid-looking bit of wood. The machine is so perfectly adequate to its work that there was not even the slightest perceptible tremor to tell the lookers-on of the enormous force that was being exerted under their very noses, so that one was hardly conscious that the testing had begun when Mr. Kirkaldy said "Now look at the specimen," and one saw the piece of oak slowly and quietly taking the shape of a very elongated S, assuming a perceptible double curve; presently a few cracks and a bulge followed, and the pressure was stopped. Similar pieces of ash, elm, and Dantzic fir were subject to the same test. They gave in different ways, the surface almost always bursting first where any knot was. One specimen (the elm, if we remember rightly) gave by crushing up entirely in the direction of its length without twisting sideways at all; it "telescoped," in fact, and when taken out appeared to be made of two cylinders one thicker than the other, the one half having bulged beyond the face so as to leave a kind of rough fillet all round. The fir gave very suddenly, the steelyard weights coming down on the floor with a thud, but it took a very high pressure first.

The museum of fractures, occupying two or three stories above the testing-room and workshops, was inspected with great interest, and affords a great many hints and suggestions as to the behaviour of materials under various circumstances, and as to the manner in which testing may be used to determine the best and strongest form of using the material. Thus, for example, there were to be seen in one room various forms of the link or eye-piece of tie-rods for suspension-bridges and iron roofs, showing where the fracture had taken place in the various forms; in the first form tested the fracture was in the link itself, and by repeated testings it was discovered that the shank of the tie-rod could be reduced about one-fourth in thickness before reducing it to the same breaking strain as the link part; and, of course, when the breaking strain is not the same in every part of the rod, that in which it is greatest represents so much superfluous material which is thrown away. After repeatedly changing the form of the link and the proportion of metal in it to that in the shank, a form was eventually obtained in which in repeated experiments, the shank and link broke, on the whole, impartially, sometimes one part giving first, and sometimes another, so that it was then apparent that a form of equal strength in every part had been obtained. Of course this kind of investigation involves a large number of experiments from which to strike an average; but the testing of materials in isolated cases, to obtain certainty, where there is a desire to economise material without going too near the limit of strength, is the most ordinary part of the work done; and even where there is no supposed approach to the limits of strength, a test has a wonderful effect in removing all anxiety from the mind of the architect. In some cases results are obtained very different from what had been supposed to be the limit of strength before testing, as in one case of an iron standard which had been condemned as insufficient for its purpose, and which gave way only at a strain about three times the safe margin for the work for which it had been calculated. This was, perhaps, an exceptional instance; but we believe that architects, when they do their own iron-work, generally make it much stronger than necessary. The museum of tested objects includes beams and balks of various sizes, chain-links, stone and concrete blocks, rivet-plates, iron rods in nearly every shape and size, railway rails, and a multiplicity of other things, the histories and conditions of each test being all (we conclude) on record. Among the objects attention was drawn to some long pieces of Deodar pine from India, sent home for testing and report, and which we were assured had shown under test a bearing power equal to oak. There is an enormous supply of this wood if it can be economically got at, so that it is worth while to know something of it. On the whole, it would be difficult for a party of architects to have spent a morning in a way more practical, and at the same time interesting, than was afforded by the courtesy of Mr. Kirkaldy.

It may be interesting to give the results of the tests made in the presence of the visitors on the 7th, which have been furnished to us by Mr. Kirkaldy, and stand as follows:—

Description.	Test. No.	Ultimate Stress.		Stress, Lb.—Depression, Inch.					
		Total.	Per sq. in.	25,000	50,000	75,000	100,000	Final.	Set.
	M	lb.	lb.						
Oak, English	1612	93,240	3,729	·028	·069	·119	—	·682	·321
Ash, „	1613	75,630	3,025	·031	·088	·316	—	·910	·352
Elm, „	1614	102,310	4,092	·020	·052	·088	·179	·508	·139
Fir, Dantzic	1615	117,620	4,704	·019	·052	·082	·121	·475	·328

The figures, of course, do not represent average strengths of the various woods represented, which can only be arrived at by a number of tests on pieces taken from various logs; they give the strength only of the single specimens tested. Mr. Kirkaldy notes "The specimen of fir tested being free from knots and straight-grained gave way very suddenly, whereas the others, more especially the oak, having knots and being crooked-grained, yielded more or less gradually."

The last column of figures, headed "set," represents the permanent depression of the specimens after recovering as far as their elasticity would allow.

Value of City Property.—The old freehold house, No. 35, Bucklersbury, with an area of 2,208 ft., has been sold, by Messrs. Philip D. Tuckett & Co., for 21,250*l*.

FROM PARIS.

Let it make the fortune of the Rue du Sentier and the Boulevard Montmartre or not, the Exhibition has undeniably given a fillip to a number of important public departments. The building and kindred trades have profited, for the first time since the anti-communard reaction, when a fever of re-construction prevailed, and piles were sunk and foundations laid everywhere from Bercy to Batignolles. This fact is so evident, and has been so generally commented upon by the technical and artistic press, that an old idea of the Empire has at last been taken up, and the *Moniteur* of the 29th of May announces the institution of a Commission Supérieure des Bâtiments Civils et Palais Nationaux. This superior committee is supreme in an artistic as well as in an administrative and financial sense, and it will have consultative and executive authority all over France. The names that are guarantees for its artistic competence include Viollet le Duc; De Labord, the Perpetual Secretary of the Fine Arts Academy; the sculptors Dubois and Mercié; Guillaume, the new Director of Beaux Arts; Garnier, the architect; Alphand, the well-known Inspector-General of Roads and Bridges; while the industrial and economical authorities number six or seven members of the Institute, as many senators, and several "inspecteurs de bâtiments civils."

One of the early works of the new committee should be the reconstruction of the Tuileries, which has been decided upon, *en principe*, by the Government and the committee of the Chamber appointed to deliberate upon the question. But a Republican majority was not likely to sanction the entire restoration of the palace of the Medicis and Bonapartes. It is decided that only the portions yet subsisting are to be consolidated and restored. The external walls are to be strengthened and made whole; new partition walls are to be built where necessary, and old ones repaired; the roofs are to be re-adjusted with a view to the new destination of the building. All walls rising above the piazza will be reduced to that level; the end walls and terraces will be reconstructed, and a lateral façade applied to each of the pavilions, de Flore and de Maroan, or what is left of them. The committee sternly enjoin that the spirit of their recommendations shall not be departed from: that is to say, that no attempt shall be made to restore the palace as a dwelling-place. It is to be an archæological museum, or to receive the overflow of the Luxembourg picture-galleries, which are now far too narrow to house the modern art-treasures of the nation. A separate garden will surround the Musée des Tuileries.

Political influences have been at work in other ways than those of reconstruction. They have originated, or, at any rate, fostered a *furore* for statues and commemorative stone and marble, that appears to be breaking out all over the country, and occasionally in somewhat unpleasant fashions. After the Voltaire statue, which is likely to remain adrift for some time, now the exuberant enthusiasm of the centennial has evaporated, the marble effigy of Thiers will attract all Paris to the École des Beaux Arts from the 16th to the 21st of this month. The town of Nancy opened the competition, and the successful piece of statuary will be erected there. Again, there are to be festivals at Mâcon in August, on the occasion of the inauguration of Lamartine's statue; while Marceau is to posture on a pedestal in Versailles, and the astronomer Le Verrier disport himself in marble shaped by M. Chapu in the environs of the Observatory.

Another semi-political measure is the contemplated erection of some memorial in the Rue de Rivoli, on the site of the Riding School, where the Convention proclaimed the monarchy abolished for ever in France,—a premature reckoning without the hosts who might arrive that merits a signal recognition in the opinion of M. Cernesson, municipal councillor and conscientious Republican. The site is now occupied by No. 230, Rue de Rivoli and a wing of the

Hôtel Meurice; but there are already half a score different opinions put forth as to the real spot where a monarchy fell, and an empire was born to the noise of the Vendémiaire guns.

M. Bardoux, the Minister of Public Instruction, has projected a novel institution, which seems to be destined to render important aid to the cause of technical education. It is a Museum of Pedagogy, whereof the title is infinitely less attractive and commendable than the purpose. In addition to the collections of educational instruments, books, statistics, &c., the museum will be especially strong in plans of school-houses, models of colleges, and schemes for the erection of economical communal classes.

Whoever has finished his long journey from Calais at the Place Roubaix must remember, with a keen recollection of the wind, or rain, or sun that there tortured him, the monster court of the Gare du Nord. The roofing in of this small Sahara is just being completed. The area covered is 2,500 mètres. Two spaces of joists are established, each of a length of 22 mètres. The joists number eight for each space, and rest on twenty-four columns of really extraordinary lightness and elegance. A middle file of columns supports half the weight of this vast frame-work, and of these supports there are only seven,—a fact which speaks eloquently as to the excellence of the work. The entire achievement cost 320,000 francs,—a sum which most Paris builders consider wonderfully modest.

Among the buildings most recently opened at the Champs de Mars are the pavilions of the Press and the Shah. The first is a light airy edifice with the air of an opéra comique châlet, but excellently disposed and fitted within. The Persian potentate's *pied à terre* is chiefly remarkable for possessing a crystal roof and appended thereunto a crystal gaselier of gigantic proportions.

INSTITUTION OF MECHANICAL ENGINEERS.

THE second number of the proceedings of the Institution of Mechanical Engineers contains five papers which were read at the Spring Meeting of the Institution in April last, together with full reports of the discussions that ensued. The papers read were,—1. "On the Appliances and Operations for Raising the Wreck *Edith*, at Holyhead," by Mr. L. M. Kortright; 2. "On a Floating Dock upon an improved System, at the Victoria Graving Docks," by Mr. C. Elwin; 3. "On the Cost of Working different descriptions of Railway Traffic," by Mr. F. R. Conder; 4. "On Experiments relative to Steam Boilers," by Mr. W. Boyd; and 5. "On the Construction of Vessels to resist High Internal Pressure," by Dr. C. W. Siemens. Special interest attached to the first discussion, in consequence of the recent losses of the *Vanguard* and of the *Eurydice*. The *Edith* lay in only 36 ft. of water, at low spring tide, and at a distance of only 40 chains from the end of the pier at Holyhead. She was in the fair-way of shipping entering and leaving the old harbour, so that it would be difficult to imagine conditions in which the process of lifting would be at once more desirable and more likely to be accomplished with success. Great skill was displayed in the design and application of the method employed, and there seems to have been no difficulty in the way of money. And yet it took eighteen months to bring the wreck into shallow water, and the total cost of the operation was equal to the prime cost of the vessel. When this is borne in mind it may well be considered that attempts to raise the *Vanguard*, lying in 120 ft. of water, on a soft bottom, in an unsheltered position, far from the land, "could only result in failure, and the probable loss of a large sum of money." It is more than doubtful how far the same remark is inapplicable in the case of the *Eurydice*. Of Mr. Conder's paper we gave some account at the time of the meeting. Mr. Price Williams remarked, with regard to it,—"One result of this interesting and important paper, he hoped, would be, that the railway administrators might be induced to afford the means of drawing more reliable conclusions as to the cost of the traffic. He was aware that some railway companies held it was better for the public that they should not know the cost of carrying a passenger and carrying a ton of goods. On the contrary, he maintained it was essentially their interest, as it was the interest of the public, to know the exact facts, as by that means alone would the public be able to help the railway authorities themselves in economising in any form and way." The President remarked that "the eagerness with which the discussion had been carried on showed the great interest taken in this matter by engineers, whatever might be the case with railway shareholders." The papers relating to steel boilers and to resistance to pressure are of a more technical nature, dealing as they do with matters of great importance. The volume of Proceedings is a valuable addition to the rapidly-increasing library of the English engineers.

THE ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS.

THE annual meeting of the Association of Municipal and Sanitary Engineers and Surveyors was held at Southport on Friday, the 24th ult., under the presidency of Mr. Ashmead, of Bristol, when there was a considerable gathering of engineers and surveyors from different parts of the country.

The principal subject discussed at the meeting was the main outfall sewer at Southport, designed by Mr. Mansergh, C.E., which is just upon the point of completion. A description of the sewer, compiled by Mr. Crabtree, the Borough Surveyor, was read. The writer, after giving an account of the growth of the town, and of the consequent great necessity for a system of sewage, minutely described all the constructive features of the sewage works in detail, from which it appeared that the total length of the sewers is 9 miles 1,401 yards. The arrangements for the flushing of the sewers were described as being of the most perfect character, and it was explained that one of the sewers (that in Nevile-street) is flushed from the public baths, which have one bath containing 65,840 gallons, two of 50,000 gallons each, one of 55,228 gallons, one of 45,668 gallons, one of 40,608 gallons, two of 28,000 gallons each, or a total of 332,000 gallons, which in the summer season are emptied every night, and in winter twice a week. At the conclusion of the paper, which was read by Mr. Morrow, the Assistant Borough Surveyor, the members of the Association proceeded to visit the main outfall sewer, now approaching completion, Mr. Morrow accompanying the party, and explaining the details of the different objects visited.

On the return of the party to the Town-hall Mr. Ashmead again took the chair, and invited discussion, upon which

Mr. Lemon, of Southampton, the past-president of the Association, made some practical remarks in reference to the sewage works which they had just inspected. The town appeared to be of an exceptionally flat gradient, and very special means seemed to have been devised for preventing any deposit in the sewers. In reference to the flushing arrangements, he thought they were very complete, and would have the desired effect. The velocity they had seen was very good, but he was told that on ordinary occasions it was only at the rate of 1 ft. 6 in. per second. That was a very low fall, and as engineers they knew that was not sufficient to keep the sewer clean. Whether the flushing would have the desired effect or not, time alone would show. Of course he did not wish to criticise a scheme which had been designed by such an able engineer as Mr. Mansergh, but he was rather opposed to the principle of what he considered reservoir sewers. He thought it was far better to have a sewer suited to the capacity of the work it had to do. Here sewage was provided for by means of reservoirs. There were advantages in this system over the reservoir system in this way, that the deposit was washed down by the sewers into the reservoir, and was in a position where they could get at it rapidly. The sewers generally appeared to be of broad good capacity, judging from the size of the town. He understood the population was about 32,000. Of course it was a district which increased at an enormous rate, and he should like to know what was the prospective population provided for under the drainage scheme. As regarded the ventilation scheme, he agreed with the principle of having direct outlets into the streets. It was, in his judgment, the best mode of sewer ventilation.

Mr. Thorburn, of Birkenhead, said he thought that at a place like Southport, which was built on sand, and where there was a substratum of sand, it required very special arrangements to provide for the efficient discharge of sewage, and the plans seemed to have been designed with very great care, and appeared to have been equally well worked out.

Mr. Lemon wished to know if any observation had been taken of the current of sewage after its discharge from the outlet? He asked the question because it was only the other day that he had been instructed by the Southampton corporation to prepare a scheme for the purification of the sewage of the borough, the council not being satisfied about the discharge into the sea. It was very often of an unsightly appearance through being taken out by the tide and washed back again. In these days of sanitary science they were expected to do something better than discharge the sewage into the sea.

Mr. Morrow, in reply, said Mr. Mansergh had gone carefully into those matters, but he was not aware of the result. Mr. Morrow added that their sewage scheme was computed for a population double that of the town at present.

After some further discussion, a vote of thanks to the Chairman concluded the proceedings.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

AT a meeting of this society on Thursday, the 30th ult., a paper was read on "The Design and Construction of the Portishead Docks," by Mr. M. Curry, jun., A.K.C. Lond., Assoc. Inst. C.E.

The author described and illustrated by a series of coloured wall-diagrams and photographs—(1) The site and general design of the works, which, being on the site of the Portishead Pill, or estuary, at the mouth of the Avon and on the Bristol Channel, will afford for Bristol further accommodation for its ocean steam-traffic. The velocities of the tides, the great range, 48 ft. at high springs, with rapid rise, 12 ft. per hour, and the tendency to silt, &c., were described; and the nature of the site, a deposit of soft mud on the red marl with new red sandstone, and to which the foundations were carried. The jetty, with the outer quay-wall, forms a guiding pier of 970 ft. to the entrance. The lock is 566 ft. total length, 66 ft. wide, and 41 ft. deep, to accommodate a ship 450 ft. by 65 ft. beam. There are two pairs of wrought-iron gates having single skins, and which weigh but 72 tons per leaf; also a floating caisson. The dock, 1,800 ft. by 400 ft. wide in bottom, has an area of twenty acres, besides a timber-pond of fifteen acres, with a quay-wall along the railway wharf, and formed to a slope on the opposite side. (2) The mode of construction. The cofferdam, 530 ft. long, with puddle-chamber, 7 ft. wide, and piles 55 ft. long, was carried across the mouth of the estuary, but on the eve of completion failed, from the unstable nature of the mud bottom. The masonry entrance with outer return wall was then completed by tidal work,—a half-tide timber trench being driven through the mud, with a staging for wagon and crane roads, and by a temporary dam of iron lattice girders with outside planking, the water was effectually shut out, enabling the rest of the works to be constructed free from tidal interference. In the lock the masonry along one wall was first got in and used as a buttress for strutting the trench of the opposite wall and the moving bank behind it, the invert being formed last of all. The dock was excavated by hand labour, and the material removed to the quay banks by locomotives, winding inclines, and swing roads, the bottom being too soft to allow the use of mechanical excavators, excepting the chain pump and an elevator used for the slurry. The author, who as contractor's resident engineer, had set out the works, concluded the paper with (3) a sketch of the development of the Port of Bristol, showing the necessity for the new docks.

In the discussion which followed, Messrs. A. C. Pain, Howard, Street, Love, and the President, took part, and the proceedings terminated with a vote of thanks to the author for his very valuable and interesting paper.

The annual meeting was held on Thursday, June 13.

CLEOPATRA'S NEEDLE.

SIR,—Say a word for a lightning conductor. Ditto to pick in the hieroglyphics with gold or blue. Ditto as to the back slums behind the Embankment gardens, opposite. The gardens serve as a "dickey" to a dilapidated shirt.

R. T.

ON SOME OF THE LIABILITIES OF URBAN AUTHORITIES IN THE EXECUTION OF WORKS.

THERE are very few Acts of Parliament passed of any importance which have not sooner or later to be explained by the courts of law. The Public Health Act of 1875 forms no exception to this rule. The point in regard to it upon which we intend to offer a few remarks is one of a good deal of practical importance, and is worth the attention both of Urban Authorities and the owners of property.

The principle involved relates to the extent of the authority of Urban Authorities for what may be termed voluntary works,—that is to say, works which they themselves are not bound to execute. Of course, no Urban Authority is liable to proceedings of any kind, legal or not, for not undertaking works in regard to the execution of which no duty is cast upon it, but there is a difference between the primary liability to undertake works, and the undertaking of works voluntarily, and the liability towards third parties which arises in consequence of and during the performance of such work.

Now the principle which, shortly stated, seems to be applicable to this class of facts, is that when an Urban Authority voluntarily undertakes work connected with its sanitary duties it is liable for any consequences which may result from such work. If, on the other hand, the work be such as is outside the scope of its duties, and the undertaking of which is, accordingly,—to use the technical term,—*ultra vires*, beyond its authority or power, then they are not as a corporate body liable for the consequences which result from such work. This proposition may be illustrated, and its practical application and importance shown, by certain facts which have recently afforded ground for legal argument and for judicial decision. The case itself is that of Hall and Others *v.* The Mayor and Corporation of Batley (47 *Law Journal* Reports, Queen's Bench Division, p. 148). The circumstances, shortly stated, were these: in May, 1876, the Urban Authority, that is to say the defendants, constructed a sewer in Wellington-street, in Batley. Passing over some intermediate facts of no importance, the time arrived when it became necessary for a new drain to be made from the mill of the plaintiffs, either to a cesspool, since the mill was more than 100 yards distant from the main sewer, or into this main sewer itself. That would be under the provisions of Section 23 of the Public Health Act of 1875; and under the same section, after the notice had been given to the owner of the premises that such work was required, if he did not take it in hand then the Urban Authority would do it, and charge the cost to the owner.

Accordingly the plaintiffs were quite willing that the work in question should be done, but instead of doing it themselves they requested that it should be done by the Urban Authority, or rather by its workpeople, and that the Authority should be paid a proper sum by the plaintiffs. In fact, the Urban Authority was placed in exactly the same position as regarded the work as if it were an ordinary contractor, between whom and the owner of the premises an agreement to do certain work had been made. The workmen of the Urban Authority accordingly set to work, and during its progress had to dig a trench for the drain under the paved footway. This trench was dug close to and considerably deeper than the foundation of the plaintiffs' building. Moreover, it was done all at once, without underpinning, and without merely opening it as the work proceeded. The very natural consequence of this clumsy manner of proceeding was that part of the mill subsided, and a good deal of damage ensued. Nor is it wonderful that there was yet a further consequence, namely, an action by Messrs. Hall & Co. against the Mayor and Corporation.

The case was decided in favour of the plaintiffs, upon the grounds which we have already mentioned as the guiding principle in such cases. If, on the other hand, the Urban Authority had entered, to quote from Mr. Justice Lush, "into a contract to build a house, or a wall, or to do any other work unconnected with its functions as a sanitary body," then it would not have been liable for this damage. It may be asked, was the Urban Authority well advised in undertaking this work at all? As it seems to us, it was most reasonable that the mill-owners should request the Authority to perform it, and most proper that it should accept the offer. The Act requires that the work shall be one by one party or the other, and surely the owner may waive the option given him by the Act, if he pleases, and agree with the Urban Authority that the needed work shall be made by it. For it is precisely the work which it is required to do in the event of the owner declining it himself; its workmen are acquainted with the system of drainage existing in the locality, and with the character of the locality itself, and should be the most competent and the most proper persons to undertake the work. The moral, therefore, of this case seems to be, in addition to the principle which it unfolds, that Urban Authorities should be careful to have experienced and prudent workmen. Large powers are being continually given over to public bodies, and it is most important that no opportunity should be lost of pointing out how frequently the necessity is shown of careful superintendence of those who perform public works. There is a greater tendency to carelessness in those who work for public bodies than for private persons, and it is most important that they should be kept strictly to their duty. In that light, therefore, the examples we have given may be useful, as well as exemplifying the working of a part of the Public Health Act of 1875.

A YEAR'S WORK AT THE BRITISH MUSEUM.

IT is almost impossible for those who merely visit the British Museum for the purpose of study in the gigantic reading-room, or to inspect the curiosities collected in some one department, to grasp the unique and magnificent character of the Museum as a whole. The treasures of every sort of literature, of art, and of natural history are really prodigious; but a glance at some parts of a single year's work (*i.e.*, from March, 1877, to March, 1878) will make its special character more clearly visible. But though we can hardly hope to present a very systematic view of such a *mélange* of matters as is presented to our view, still even to touch partially on this subject cannot fail to interest many of our readers.

To take for our first example the Department of maps, charts, plans, and topographical drawings. Here, to take only one portion of the year's work, 230 atlases and 2,759 maps have been obtained, and eight volumes and 593 maps and drawings have been presented. Many of these are not of a kind which would have a more than merely curious interest for the readers of the *Builder*, but some among them are of a highly attractive character. For example, the Rev. Precentor and Prebendary Walcott presented 226 drawings, views, ground-plans, and engravings of churches, castles, and abbeys in England and Wales. Then, again, there are twenty-four plans of British earthworks, quite a unique collection; and then we have a most curious map of the Tagus, with a plan of Lisbon, showing the embarkation of Catherine of Braganza, which was presented by the late Sir William Stirling Maxwell, and which was taken from the unique etching in the print-room by Dirk Stoop. But, as we have said, these are merely examples of innumerable new acquisitions. To turn next to the department of Oriental antiquities, we need not dwell on the various arrangements of what the Museum already possessed, but may go at once to some of the 239 new acquisitions. Of these, among the most noticeable is the ivory torso of a small figure of Aphrodite from Thebes, a terra-cotta figure of Horus borne in a chair by two priests, the latter of the Roman period, to which the following also belong: a bust of Isis, of large proportions, and a very curious lamp in the shape of a horse. Then, again, there are a collection of objects from Van, presented by Sir Henry Layard, including such interesting things as a plate representing the walls of a city, and a terra-cotta figure of the goddess Neith in Phœnician archaic style. When we reach the Department of Greek and Roman antiquities, it is difficult to choose examples from among the thirty-three new objects. There are, however, to take the two first, a plaster cast from a fragment of the frieze of the Parthenon, formerly at Cataio, and now the property of the Archduke Carl Ludwig, of Austria; and secondly, a marble slab, from a Roman arch at Salonica, with a Greek inscription containing the word *politarchos*, which was the title of a magistrate at Salonica.

Passing on to the Department of Prints and Drawings, we come upon a large number of objects which have been acquired during the past year. Indeed, no fewer than 10,374 acquisitions have been made, and the fact that of these 2,411 examples have been presented, says a good deal for the generosity of individuals. For there is no very great generosity shown by a man who bequeaths some precious object at his death, but there is a good deal of self-denial shown by the person who, during his life-time, presents some much-prized relic to the nation. For every one knows that collectors have a certain pride in being able to point out to their friends such and such unique and valuable object. But when this object is labelled among thousands of others with the name of the donor, it is lost in the multitude which surrounds it. Probably the most interesting of the new objects in this department, and we should say, on the whole, the most curious, is the highly-important collection of drawings, 1,417 in number, illustrating the manners and customs of the Chinese at the present day, their trades and shops, ceremonies, scenes in domestic life, modes of punishment, views of buildings, landscapes, and other subjects. All these are by native Chinese artists, some being very highly finished in water-colours, the rest drawn with the pen in outline. Added to these are eight small Chinese sketch-books. So that we have here not only a pictorial description of Chinese life and manners, but also specimens of Chinese art, which would of themselves be valuable. For this unrivalled collection the nation is indebted to Miss Reeves. Then, again, among the engravings we find a sequence of twenty small prints engraved in the "*manière criblée*," and coloured, illustrating the Ten Commandments; and, more curious still, the consequences attending the transgression of them. Rhymed inscriptions in Latin and German accompany the designs, the German text being in the Swabian dialect. The place of their production was probably the district lying between Basle and Strasburg, and the date is spoken of as probably the last quarter of the fifteenth century. The set is, however, unique, as far as is yet known, and has not been hitherto described by any bibliographer or art-historian. Next there is the Great View of Cologne by Wenzel Hollar, engraved on four plates, presenting a view of the whole extent of Cologne and Deutz, with their fortifications. Of the first edition there are only two other copies extant,—one at Cologne itself, the other in the Imperial Library at Vienna. These few examples will, we are aware, give but a poor idea of the labour which is going on in cataloguing and arranging old and new works at the British Museum; but they show to some extent, at any rate, how new treasures are annually and continually flowing into our great national museum, and how from every quarter of the globe, from the distant East, and from the humble villages of England, new specimens of the works of Nature or of the ingenuity of man are being added to what is in itself a history of the world.

A ROOM FROM JAPAN.

WITH the aid of Dr. Dresser, the Governor of Kioto, and a master of the ceremonies, who appears to take the place in Japan of a district surveyor, Mr. Streeter, the jeweller, of New Bond-street, obtained and has fitted up a Japanese room of high character, in which all the necessary points of etiquette have been attended to. For example, in all the good houses of Japan, a niche is arranged in one room in which the Mikado would sit if ever he entered that house. As the god-incarnate of the Shinto Church, the Mikado could not sit in that niche unless the post which forms its boundary at one side was of unplaned wood, the walls of this niche undecorated, and the roof formed of one piece of wood. "The master of etiquette arranges the parts of the dwelling so as to suit this and other purposes." The room is low and small, and of unpainted wood, planed to such a degree of perfection that sand-paper might be suspected if it were not positively stated to the contrary, and put together without nails. The workmanship throughout is, in fact, wonderfully good, and we advise some of our young joiners who intend to elevate their trade to go and look at it, as well as some of our richer readers, who might like to buy it. Could its fellow be equally well made in England? We doubt it. But we have no doubt when we ask the same question in respect of a silver tea-service, oxidised and ornamented with gold and enamels, to be seen at the same establishment, for we know very

well that the answer must be in the negative. Is not this a shameful fact, and ought we not all to feel ashamed of ourselves?

THE OLD KENSINGTON WORKHOUSE AND SPECULATIVE BUILDING.

SOME time ago the combined vestries of St. Margaret's and St. John's, Westminster, agreed to sell the old workhouse at Kensington, but at a meeting of the vestries last week, the question of disposing of the building again came up for discussion on a recommendation from the parish property committee to the following effect:—That having regard to the large amount of speculative building in progress in the immediate neighbourhood of the workhouse property, in Marloes-road, Kensington, belonging to these parishes, and also having regard to a heavy failure in the building trade, they recommend that it be ascertained whether the Kensington and Chelsea School District are still open to treat for taking the premises for two years certain. It appeared from a statement by Mr. Aston that the Kensington School authorities did not wish to take the property, but that the Chelsea managers desired to secure it. He said that the managers were not likely to give the enormous sum of 2,500*l.* yearly for the place (which was asked), but probably they might hold to their former proposition of a rental of 1,800*l.*; and he moved that the previous resolution of the vestry, agreeing to sell the property forthwith, be rescinded, and that the building be let to the Kensington and Chelsea School authorities for two years and a quarter, at a yearly rental of 1,800*l.* Several members opposed the proposal, and advocated an immediate sale of the building, Mr. Harris observing that 21,000*l.* had been offered for the property, whilst Mr. Horn, in urging a sale, said he had no doubt the property would realise 50,000*l.* or 60,000*l.*, Mr. Aston, however, contended that as the land was freehold, the delay would cause no loss whatever, and that at the expiration of the period he had mentioned they could sell it to better advantage than at present. The proposal to let the building was adopted.

ELECTION OF FOUR DISTRICT SURVEYORS.

As most of our readers will know, Mr. Henry Baker, "the father of the District Surveyors," recently died.* He had held the appointment of District Surveyor for St. Pancras for the remarkable period of fifty-three years. During that time, the district, like all our suburbs, has wonderfully changed by the spread of our "province of bricks and mortar" over what were once green glades and pleasant pastures, and on Mr. Baker's death the Metropolitan Board of Works decided to cut up the district into three parts, east, west, and north. To fill up the vacancies thus created (as well as a fourth, caused by the resignation by Mr. J. H. Good of the District Surveyorship of All Saints, Poplar and St. Mary's, Stratford,†—which he had held for a great number of years), was one of the first items of business on the *agenda* of the Metropolitan Board of Works on Friday, the 7th inst.

Before proceeding to the election, Mr. George Vulliamy, the Superintending Architect, submitted a report relative to the remuneration of the district surveyor *ad interim* of St. Pancras, Mr. R. L. Sibley, who was appointed to that position on the 3rd of May. Mr. Vulliamy stated that the average annual amount of fees received in the district during the three years ending with 1877 was 946*l.* The estimated proportion of that amount, which was due to Mr. Sibley during the time he had acted as interim surveyor, was 81*l.* As the district was to be divided into three portions, and as the fees for work done by Mr. Sibley had not been collected by him, Mr. Vulliamy recommended that, in consideration of Mr. Sibley surrendering his claim to the fees in favour of the surveyors to be elected, each of the successful applicants for the three districts of St. Pancras be asked to pay the sum of 27*l.* to Mr. Sibley for services rendered by him.

This was agreed to, and,

On the motion of Mr. Selway (acting for Mr. Furniss, the Chairman of the Building Act Committee), it was resolved:—

"That the number of candidates in each case be reduced by one vote to six; that the names be then put to the vote *seriatim*, and that the candidate having the least number of votes be struck off at each voting.

That the appointment of District Surveyors do continue during the pleasure of the Board, and be subject to the condition that they shall make no claim for compensation in case a diminution of income shall at any time hereafter arise from any reduction or alteration of fees by the Board, or from any change of system which may be adopted, either as to the office, its duties or emoluments, or from any division, reduction, or re-adjustment of districts.

That the appointment of District Surveyors be subject to the condition that they shall furnish the Board with information of those cases in their districts in which the orders of the Board, or the requirements of the Local Management Amendment Act, 1862, with regard to the width or entrances of streets, or to any building, structure, or erection, or projection therein, beyond the general line of buildings, are not complied with, and of those cases in which the limitations contained in the Building Act as to the cubical contents of buildings are exceeded.

That the District Surveyors to be appointed this day be required to keep their district offices open daily from ten a.m. until four p.m.

That in the event of a candidate who already holds a similar position being elected to either of the vacancies, he be required to resign his previous appointment."

The following is a list of the whole of the candidates for each of the four surveyorships:—

Aitchison, G.*†; Allom, A.; Badock, J. B.; Baker, W. A.†; Bell, R. B.; Bovill, A.; Bromilow, J.†; Brooks, C. W.; Burden, R. H.; Carritt, E.; Clarkson, J.; Conder, A.; Dale, D. R.; Edmeston, J. S.; Ferguson, J. M.; Grose, V. J.; Hammond, F.; Karslake, L.; Large, W. A.; Leonard, W. C.; Lovegrove, H.; McDonell, G.; Nash, W. H.; Notley, F. C.; Payne, A.; Quilter, J. S.; Stone, F.; Stone, T.; Street, E.†; Tasker, W.; Todd, F.; Turner, J. G.; Turner, S.†; Wallen, F.; Williams, T.; Willis, T. W.; Young, J.

Proceeding in accordance with the foregoing resolutions, the preliminary voting was taken in each case, to reduce the candidates to six. We have not space to give the numbers recorded for each candidate in the preliminary votings. The subsequent voting in the case of each district was as follows:—

St. Pancras West.

	Second Vote.	Third Vote.	Fourth Vote.	Fifth Vote.	Final Vote.
Bovill	25	21	22‡	20	16
Clarkson	23	23	23	18	—
Grose	34	28	22‡	—	—
Payne	19	16	—	—	—
Wallen	33	32	29	32	29
Willis	16	—	—	—	—

Mr. Wallen was therefore elected.

St. Pancras North.

	Second Vote.	Third Vote.	Fourth Vote.	Fifth Vote.	Final Vote.
Aitchison	19	17	14	—	—
Bovill	27	28	29	27	28
Clarkson	25	24	22	17	—
Grose	30	19	19	24	16
Hammond	10	—	—	—	—
Willis	19	10	—	—	—

Mr. Bovill was thus the successful candidate.

St. Pancras East.

	Second Vote.	Third Vote.	Fourth Vote.	Fifth Vote.	Final Vote.
Aitchison	21	23	22	16	—
Clarkson	29	27	26	23	21
Edmeston	12	—	—	—	—
Grose	28	28	25	25	23
Payne	16	18	15	—	—
Willis	14	12	—	—	—

Mr. Grose was therefore successful.

All Saints', Poplar.

	Second Vote.	Third Vote.	Fourth Vote.	Fifth Vote.	Final Vote.
Allom	15	15	14	—	—
Carritt	14	—	—	—	—
Clarkson	35	34	37	33	36
Payne	21	19	17	14	—
Williams	15	11	—	—	—
Willis	21	20	25	18	12

The successful candidate in this case was Mr. Clarkson, who, like the other "lucky ones," thanked the Board for his election and promised to serve them well.

THE NEW PUBLIC RECREATION-GROUND FOR LEWISHAM.

THE public recreation-ground at Sydenham, for the benefit of the residents within the district of the Lewisham Board of Works, which was formally opened the other day by the Earl of Dartmouth, is 17½ acres in extent, has cost about 10,000*l.*, although not yet quite completed. The land alone cost 8,500*l.*, towards which the Metropolitan Board of Works contributed one-half; and the trustees of the Lewisham Charities 1,000*l.*; the inhabitants of the Lewisham district, including Sydenham and Forest Hill, contributing the remaining portion. Under the Act of Parliament obtained last year, which sanctioned the purchase of the land and the laying-out of the ground, the Lewisham District Board of Works are bound to maintain the ground as a place of recreation for ever, and to keep it in a good state of repair. The ground, which has been converted into a handsome resort, is situated just below the Sydenham Railway Station, and contains some fine old oak timber. A portion of it, comprising five acres, has been levelled for cricket and other sports; and one point in the cricket-ground is that it is almost square, and is surrounded on all sides by fine old oaks, beneath which seats have been fixed, where the visitors will be able to sit and watch the sports. The ground has been planted with shrubs, and serpentine and other walks have likewise been constructed. Sir James Hogg, chairman of the Metropolitan Board of Works, was present on the occasion of the opening of the grounds, and during the proceedings he remarked that the Board had been able, during a few years, to keep for the people at large not less than 1,300 acres of open spaces, and they hoped to be able to get 300 or 400 more during the ensuing session of Parliament. He was glad that the inhabitants of Sydenham and the district had not waited until the beautiful ground they were standing upon had been filled up with bricks and mortar, but had looked before them and secured it.

THE LEGAL ASPECT OF CONTINUOUS WORK FOR WORKMEN.

IN an appeal case, Marsh *v.* Bagnall, argued in the Exchequer Division of the High Court of Justice before Chief Baron Kelly and Mr. Justice Hawkins, the moot point as to employers being compelled to find continuous work was decided.

It was first tried as a test case in the Gateshead County Court. The plaintiff, Marsh, claimed 2*l.* for wages which he alleged to be due to him in respect of twelve working-days, under a notice to leave, when the defendant neglected and refused to provide him with continuous work.

The defendant contended that four days' work actually provided was a reasonable amount of work to find under the then existing circumstances, and that employers were not bound to provide more than reasonable work; that more work was not provided, and that plaintiff and others were refused permission to leave during the currency of their notice, in the expectation of their services being fully required.

The judge of the county court held,—"That under the contract of hiring the obligation on the part of the defendant was to find work for the plaintiff when work was to hand; and he could make no distinction between the period when the plaintiff was serving the defendant under his contract and that when he was under his notice to leave," and directed judgment for the defendant to be entered.

Against this decision the plaintiff appealed by a special case. The Court upheld the decision of the county court judge, and dismissed the appeal.

THE SOUTH LONDON MUSEUM PROJECT AND THE SURREY GARDENS MUSIC-HALL.

ALTHOUGH the efforts which have on more than one occasion been made to establish a museum in South London have hitherto been attended with failure, there is a probability that the laying out of the Surrey Gardens Estate for building purposes, which is now in progress, will be accompanied by the carrying out of the first-named object, and that on the Surrey side of the Thames a museum and gallery will shortly be established. As is well known, the large music-hall and theatre form a prominent feature in connexion with the gardens now undergoing conversion. We believe it was originally the intention of the freeholders, Messrs. Sutton and Dudley, to take down the structure in clearing the ground for general building purposes. It appears, however, that this resolve is not now intended to be carried out, and that the freeholders have voluntarily made an offer to convert the music-hall and theatre into a museum and library, together with picture and other galleries, for the general benefit and instruction of the residents in South London. The proposal is accompanied with what seems to be a very liberal offer, in addition to the con-

* For a brief memoir, see *Builder*, p. 451, *ante*.

† The southern portion of the parish of St. Mary, Stratford-le-Bow, has, by resolution of the Board, been added to the district of Bethnal-green East, of which Mr. Thomas Blashill is Surveyor.

* District Surveyor for Woolwich.

† Not candidates for All Saints', Poplar.

‡ On a vote as to which of these names should be retained for the fifth vote, the numbers were:—Bovill, 22; Grose, 19.

version of the structure. In the event of a committee of responsible gentlemen being willing to undertake the working of the proposed institution, the owners will grant a free use of the buildings when converted, at the nominal rent of 5*l.* per annum for three years, to be renewed at the end of that time for another three years, should the project succeed, and after that period to grant a lease of ninety years on the same terms. The freeholders having communicated their proposal to a number of gentlemen in the locality interested in the establishment of such an institution in this part of the metropolis, a meeting has been held at which there was an interesting discussion on the subject of schools of art, museums, and free libraries; and ultimately it was resolved to convene another meeting of a more public and general character in order to make the proposal fully known. This meeting is immediately to be held, when it is expected that several gentlemen of influence interested in literature and science will attend and take part in the proceedings. It is confidently expected that with such an exceptionally advantageous offer the project will be warmly taken up and adopted, and that the authorities at South Kensington may be induced to give their encouragement and support. The hall was built some twenty years ago, Mr. Horace Jones being the architect.

THE PROPOSED NEW ASSIZE COURTS AND SHIRE-HALL AT BEDFORD.

THE TOWN COUNCIL *v.* THE MAGISTRATES.

MR. ALFRED WATERHOUSE has been called in by the authorities at Bedford to prepare plans for the new Shire-hall and Assize Courts, which it is proposed to build at Bedford for county purposes as well as for the transaction of the borough business; but it appears that there is some misunderstanding between the Town Council and the Magistrates at Quarter Sessions as to the kind of building which shall be erected. The Magistrates seem to wish to have the present Courts altered, and the Chairman of the Quarter Sessions is said to have given instructions to Mr. Waterhouse to prepare plans for utilising the existing Courts, although a joint-committee of the Council and the Magistrates had desired him to furnish designs for an entirely new building. In the course of a discussion which took place on the subject at the meeting of the Town Council last week, Mr. Alderman Horsford stated that he had reasons to know that Mr. Waterhouse entirely objected to carry out the Magistrates' proposal, and, from what he had heard, Mr. Waterhouse would have nothing to do with the project unless he was allowed to carry out a new building which should be suitable both for borough and county purposes. The plans which Mr. Waterhouse had already laid before them were extremely well adapted for both these purposes.

Alderman James Howard (at present high sheriff of the county) deprecated the chairman of Quarter Sessions intervening between the joint committee and giving instructions to the architect, and also to their surveyor, with reference to the proposed buildings. He repudiated both steps, when the joint committee of magistrates and the town council had not finished their labours.

Alderman Coombes said the great interest which the borough had in this question was that they should have a building giving every accommodation required by the judges, so as not to lose the advantages of Bedford continuing the assize town of the county. He did not attach very much importance to the advantages which the new building would offer to them as a borough. The great object was to have a building worthy of the town and county, and to secure to Bedford the continuance of its being the assize town.

The feeling of the Council was unanimous in adhering to the original project.

Cardinal Manning has laid the foundation-stone of a new Roman Catholic Church at Quex-road, Kilburn. The new building is from the designs of Messrs. Pugin, Ashlin, & Pugin, and will be constructed of brick and stone, in the Gothic style of architecture. Only one-half of the church has as yet been contracted for, the designs comprising a temporary sanctuary and sittings for 430 persons. The cost of the present portion of the structure is estimated at 6,000*l.*

THE SCOTT MEMORIAL.

SIR,—At the time of the formation of the committee for founding a memorial to the late Sir G. G. Scott, various suggestions as to the form the memorial should take were made, and amongst them was that of completing the Architectural Museum, as previously urged, too, in your pages. This suggestion appears to have been overlooked, and the proposal to found a scholarship at the Museum, and place a tablet in Westminster Abbey, seems in highest favour just now.

While readily admitting that a tablet is not only desirable but necessary, I would respectfully urge that before a scholarship the completion of the Museum itself has a prior claim.

Sir G. G. Scott often said that the collection of details of Classic architecture was miserably inadequate; and, if I am not mistaken, his last gift to the Museum consisted of casts of Classic ornamented mouldings. The school, too, requires enlarging, and its fittings and furniture need various additions and alterations to make them thoroughly efficient. Sir Gilbert always took a great interest in the school, and was ever ready to do anything in his power to promote its welfare.

Were the subject fully considered and fairly discussed, I feel that most people would agree with me that no more suitable memorial could be proposed than to make the Museum and school worthy of the name it bears and the profession to which it belongs.

OWEN GIBBONS, late Curator, R.A.M.

MURAL PAINTING.

SIR,—In listening to the discussion on this subject, which followed Mr. Armitage's paper at the Royal Institute of British Architects, I must say that I was somewhat surprised to find that the word "decorative" was used by most of the speakers to express a kind of art which, from its slighter and less perfect description, could be executed at a cheaper rate than the best; and this when every one connected with art ought to know, that the finest works of art that have ever been executed in painting and sculpture have been "decorative" works. To wit, the Phidian sculptures of the Parthenon and the frescoes of Michelangelo and Raffaelle. These works were certainly beyond all pettinesses, and simpler and grander than the common ruck of art, yet not on that account the less complete, but rather of a completeness requiring the utmost skill to effect. There is nothing so simple as simplicity, and nothing so difficult of attainment. But this simplicity is a very different thing to slighter and cheapened work, and ought to receive the very highest remuneration that could possibly be afforded. The promulgation of this fallacy with regard to the slightness of "decorative" art is tending to reduce mural painting to a kind of stencilling, which may be supplied wholesale and retail by the art-manufactories. Of course, I do not advocate the employment of easel-picture painters on mural decorations, nor easel-picture prices for mural work.

Art applied to monumental purposes requires an altogether higher training than that necessary for the ordinary painter for exhibitions. In England people are still so ignorant of the principles of art as not to be able to discriminate art from art. You shall find all heaped together under the same category by the silly reviewers. The mistake made in the Houses of Parliament was made from this very want of power to discriminate between the different requirements of different kinds of art; the consequence was that ordinary easel-picture painters who were quite unversed in the kind of art and unpractised in the methods required of them, were employed upon the work. The ignorance on these subjects is so crass, that if Morland, Sir Joshua Reynolds, Gainsborough, Hogarth, and Sir Thomas Lawrence were living, I have not the least doubt they would all be invited to decorate St. Paul's.

It is strange, too, to find any one in these days advocating the use of stained glass, save and except in very moderate quantity, in conjunction with important mural works. Colour upon an opaque surface must always compare disadvantageously with that transmitted at a vastly higher pitch through glass. The more florid style of Gothic may be acknowledged to be unfit for pictorial decoration upon a large scale; its surfaces being so crowded with ornamental panelling that little space remains for the pictures. Another objection to the application of painting to Gothic architecture is the use of stained glass. A decoration so suitable in many instances to Gothic windows is incompatible with the due effect of paintings on the walls, the colours of which require to be displayed by a colourless, and at the same time a sufficient, light. This objection is met by the consideration that stained glass is not desirable nor usual in all Gothic buildings to the extent to which it was employed in those of a sacred character. Its application elsewhere was generally less profuse, and might be so contrived as not materially to interfere with the quantity or the quality of the light. But the full power of glass-painting could never be tolerated by good taste where mural painting is to reign.

I must again endeavour to rescue fresco from its detractors. Fresco was used in preference to all other methods by the great Italian masters, as may be gathered from a glance at that list of works which I have appended to my treatise on Mural Decoration. I do not know any Englishmen who by their study and practice are qualified to give a reliable opinion on fresco-painting. A great many frescoes have been retouched. The truly British notion of expecting works of art to be executed in materials which shall last till domesday did not enter the minds of the Italians. A fair lease of the beauty was all that was expected of the materials which preserved it. The artists at Westminster dabbled with the materials of fresco, but never knew how to use them. They had, indeed, the very finest material, the very finest lime,—a lime finer than that used at Munich:—

MUNICH.		DURDHAM DOWN.	
Carbonate of Lime.....	80	Carbonate of Lime ...	99·6
Ditto of Magnesia.....	20	Bituminous matter ...	0·2
	100	Earthy matter and oxide of iron.....	0·2
			100

The limestone was procured from Durdham Down, near Bristol, and was burnt, slaked, grouted, and the putty carefully stored, according to the Munich directions, which were furnished, through me, by Professor Heinrich Hess. A finer lime could scarcely be obtained. I myself painted a fresco with it, which was exposed to wind and weather for many years without the colours in any way suffering. The enduring qualities of this specimen were recorded in the *Athenæum*.

When we talk about the humidity of the climate affecting fresco, under fair conditions, it is mere nonsense, for the basis of fresco is good mortar, and we know that good mortar has remained perfectly sound from the time of the Roman occupation until now. Of course, if the best of mortar be exposed to a constant saturation of saline humidity it will decay; but this is a condition that can generally be guarded against.

I believe I have discovered a method which, in its simplicity and durability, will supersede all others. But, after all, method is a matter of quite secondary importance. It is, above all things, necessary in the interests of English art, both pictorial and industrial, that mural painting should be encouraged. And after thirty or more years' talking about it, it is time that something were done. Unfortunately, talking in England appears to be taking the place of action.

W. CAVE THOMAS.

DAMAGES FOR DEFECTIVE DRAINAGE.

JOHN THOMAS LENCH, No. 9, Nicholay-terrace, sued Brian Helm, of No. 10, Nicholay-terrace, and Charles R. Cutler, of Newgate-street, City, solicitor, for 50*l.*, for damages to brickwork, joists, sleepers, flooring, staircase, and other parts of the plaintiff's house and premises.

Mr. Willis, solicitor, appeared for the plaintiff, and Mr. Norton, barrister, for the defendants.

It appeared from the evidence of the plaintiff that the house No. 9, Nicholay-terrace, was much injured by the damp, and there was water in the basement, which was traced to arise from the defective drainage of the adjoining house No. 10; and on opening the ground it was found that the pipes were not properly laid or of a proper character; and the attention of the first-named defendant was called to the circumstance, when he said he must have it looked to, but nothing was done to remedy it.

It was endeavoured to be shown, on the part of the defendants, that the injuries to the plaintiff's house had not been caused by the imperfect drainage of the adjoining premises, but the judge said he was quite satisfied that the dampness of the house No. 9, and the injuries it had sustained, arose from the defective drainage of No. 10, and that it was only a question of damages.

Judgment was given for the plaintiff for 25*l.*

VENTILATION.

SIR,—Dr. Pettenkoffer has not, to my knowledge, recorded the temperature of the air collected by him for the purpose of determining the quantity of carbonic acid gas at the upper, as compared with the lower, parts of apartments; but Professor Roscoe's similar experiments show the quantities of this gas in 100 parts of air and the corresponding temperatures to be as follows:—

	Carbonic Acid.		The quantity of carbonic acid near the ceiling is to that near the floor as
Temperature.	Near ceiling.	Near floor.	
12·5°c.	·2390	·2459	1 to 1·03
14·5°c.	·3305	·3253	1 to ·98
15·0°c.	·2696	·2948	1 to 1·09
16·0°c.	·1213	·1276	1 to 1·05
16·0°c.	·1382	·1684	1 to 1·21
23·0°c.	·3212	·2637	1 to ·82

If Mr. John Mackenzie's theory, as stated in your recent issue, were correct, the proportionate quantity of carbonic acid gas near the ceiling should decrease as the temperature increases; but the above table shows that no such rule exists; for, although the extremes happen to satisfy his proposition, yet, taken altogether, the differences are most irregular, and therefore do not do so.

Mr. Mackenzie, as is usual with most writers on this subject, ignores the effects of diffusion; but if he would only take this important element into consideration, the impossibility would be seen of laying down any but uselessly intricate laws for discovering the position of any particular kind of gas in any particular portion of the atmosphere of an inhabited room.

H. SAXON SNELL.

THE SHAM USEFULNESS OF COWLS.

THE result of the experiments to test the exhaust cowls exhibited at Leamington last year made by a committee appointed by the society called the Sanitary Institute of Great Britain, appears to have surprised most persons. It runs as follows:—

"The sub-committee appointed at Leamington to test the ventilating exhaust cowls, beg to report that they have given the matter their most careful attention, and carried out at the Royal Observatory, Kew, an elaborate series of about 100 experiments on seven different days, at different times of the day, and under different conditions of wind and temperature. After comparing the cowls very carefully with each other, and all of them with a plain open pipe as the simplest, and, in fact, only available standard, the sub-committee find that none of the exhaust cowls cause a more rapid current of air than prevails in an open pipe under similar conditions, but without any cowl fitted on it. The only use of the cowls, therefore, appears to be to exclude rain from the ventilating pipes; and as this can be done equally, if not more efficiently, in other and simpler ways, without diminishing the rapidity of the current in the open pipe, the sub-committee are unable to recommend the grant of the Medal of the Sanitary Institute of Great Britain to any of the exhaust cowls submitted to them for trial.

W. EASSIE,
ROGERS FIELD,
DOUGLAS GALTON."

May 30, 1878.

FLORAL EXHIBITION BUILDING IN IRON, MANCHESTER BOTANICAL GARDENS.

IN a notice of the Whitsuntide Flower Show, the *Manchester Courier* gives the following description of the new building just erected:—

The tent,—for tent it may be called,—is supported on an iron framework, is 324 ft. in length by 60 ft. in breadth, and contains therefore an area of about 2,200 square yards. The space thus placed at the disposal of the committee is ample to receive all the plants sent to them for exhibition, and visitors, who must remember with pleasure the enchanting sight which has before been afforded them, when, standing on the mound of earth placed at one end of the building, they are face to face with the perfect blaze of colour that the assembled plants present to their view, may anticipate in the coming show a finer spectacle than any they have yet been called upon to admire. The interior of the pavilion has been laid out in promenades and terraces, so as to increase the effect when it is filled with plants. The designs from which it has been erected were prepared by Messrs. W. & G. Higginbottom, architects, of St. James's-square. The ironwork has been carried out by Messrs. Edward T. Bellhouse & Co., engineers, and the covering of sail-cloth canvas supplied by Mr. Sullivan, tentmaker, Hulme. Along the sides, at the square end next the main road, leading to Stretford, and at the hexagonal end near the ornamental lake, fifty-five cast-iron columns, of special design, are ranged 12 ft. apart, connected at the top by scroll-work spandrils, and below by diagonal wrought-iron rods, covered at the intersections by cast-iron foliated shields. The curved roof principals are on the "bowstring" type, each of 60 ft. span, with oblique ties and light diagonal bracing. At the crown of the arch of the roof the ridge is raised in graceful curves, harmonising with the lines of principals, in such a way as to give the necessary support and inclination to the canvas, at a point where a quick passage of rainwater is essential in order to keep the inside dry and comfortable. It will be quite possible at any future time for the committee to glaze the roof.

WORK IN STORE FOR THE ENGLISH BUILDING TRADE.

THE judgment, recently given by the Railway Commissioners, in the case of the Corporation of Hastings *v.* The South Eastern Railway Company, cannot fail to create work for builders at the various railway stations deficient in accommodation, and they are numerous.

The Corporation of Hastings called on the South Eastern Railway to enlarge the Hastings Station; to provide better booking-offices, waiting-rooms, refreshment-rooms, and general accommodation therein; to lengthen and deepen the existing platforms, and to provide additional ones; better warehouse room for goods; to provide cattle-pens, and additional sidings for cattle-trucks; to enlarge the platforms of the St. Leonard's Station; and a new approach.

The railway company pleaded that these alterations would involve a large expenditure of money in the construction of buildings, acquisition of land, which were wholly unreasonable and unnecessary, and that the Railway Commissioners had no statutory jurisdiction to compel railway directors to create new buildings, &c.

Amongst numerous witnesses examined for the Corporation, Mr. Saunders, builder, of Hastings, said he frequently used the station for the conveyance of building materials. Some lime consigned to him was destroyed by its being uncovered from the rain at the Hastings station. Timber was delayed in delivery from the same incommodious station. It was necessary for his teams to cross the metals to get at the trucks in the siding. Loaded trucks of timber and materials were shunted to and fro to make room for other trucks. Under the best of circumstances it took a cart half a day to get a load from the railway to his yard. This was owing to want of building accommodation and more sidings.

Mr. Breeds said he had a quantity of building materials delivered at Hastings, and had frequently complained of their delay in delivery. He experienced the greatest difficulty in getting at his goods for want of railway accommodation.

Mr. Thorpe, late mayor, said the St. Leonards station required pulling down altogether. The Hastings station served a very large district outside the borough.

Mr. R. A. Hills, architect and surveyor; Mr. Jeffery, architect and surveyor; Mr. William Andrews, surveyor to the Corporation of Hastings, who estimated the yearly increase of houses at 250; Mr. Price Williams, M.I.C.E., and others, also gave evidence on the same side.

Mr. Walter Vernon, architect and surveyor, thought that the probable estimate for the little improvements demanded would be for St. Leonards 6,000*l.*, and for Hastings station 2,500*l.* The witness severely criticised the conditions of the stations.

The want of statutory jurisdiction having been over-ruled by the Court, Sir Edward Watkin, chairman of the railway company, was examined at great length, and said there was a sort of rule adopted by their company that any profits above what would pay five per cent. dividend should be divided with the public in the shape of additional accommodation. They enlarged and increased their accommodation at stations under a certain system, and did something every year. The Hastings station was constructed in 1851, and had been enlarged from time to time. As to the St. Leonards station, he thought the accommodation quite sufficient. The property was their own, and their duty was to serve their customers, and not to consult any town as to their plans.

Mr. Brady, the Chief Engineer to the Company, Mr. Miles Fenton, manager of the Metropolitan Railway, and Mr. Grierson, manager of the Great Eastern Railway, were of opinion the accommodation was adequate.

In a lengthened judgment, Sir. F. Peel, Chief Commissioner, virtually found the company guilty of all the long string of charges brought against them by the Corporation of Hastings, and decreed that remedial measures should be promptly taken. They are to lengthen and widen their platforms; provide more covered platforms, and a covered approach for carriages; more booking-office access; more waiting-rooms; and more space for goods.

So heavy a series of indictments against a powerful railway company has never before been sustained since the formation of the Railway Commission, and the thin end of the wedge having been inserted, other Corporations, ill provided with railway accommodation, are taking steps towards a reform.

Lightning.—During a thunderstorm which occurred in Perthshire recently the monument to General Sir David Baird, bart., the hero of the storming of Seringapatam in 1799, was struck by lightning, and irreparably damaged. It is situated on a hill between Crieff and Gowrie, and in 1832 cost over 4,000*l.* We conclude there was no conductor?

THE GERMAN AND PRUSSIAN BUILDING TRADES.

AT the last census of the German Empire, when the total population was found to be 42¾ millions (42,727,360), including 25¾ millions (25,752,404) belonging to Prussia, an enumeration of the various trades and manufactures was made, the results of which have been in part made known in anticipation of the official report. One of the novel features in this trade census is that the number of firms in each branch of industry has been officially ascertained, together with the number of operatives employed by each establishment. The building trades form one of the nineteen great groups of occupations, and present the following results:—Architects, 3,594 firms, employing 8,816 persons; building contractors, 4,703 firms, 67,947 persons; masons and bricklayers, 101,380 firms, 177,918 persons; masons and bricklayers, 101,380 firms, 177,918 persons; carpenters, 63,889 firms, 127,979 persons; glaziers, 13,306 firms, 20,331 persons; painters and polishers, 26,067 firms, 48,048 persons; plasterers, 309 firms, 833 persons; tilers, thatchers, slaters, 11,789 firms, 17,294 persons; asphalters and paviors, 3,314 firms, 6,218 persons; stove-setters, 836 firms, 1,213 persons; chimney-sweeps, 3,386 firms, 6,616 persons; and well-sinkers, 1,779 firms, 2,784 persons. Thus in the German Empire altogether there are 234,334 separate firms, giving employment in all to 485,997 persons in the various occupations classified under the head of building trades. Of these numbers rather more than half belonged to Prussia, the total number of firms in that kingdom being returned at 119,772, giving occupation to 244,589 persons. The figures show that out of every 88 Germans there is one person employed in the building trades, while the number of persons dependent on those trades for a livelihood, reckoning the families and servants of the masters and operatives, may, at a moderate calculation, be estimated at three times that proportion. That is to say, there would be at least one person in every 29 of the population supported by this great division of industry.

HEXHAM HYDROPATHIC ESTABLISHMENT.

A COMMENCEMENT has been made with the erection of a new hydropathic establishment at Hexham, Northumberland. The undertaking is in the hands of a Limited Liability Company, with a capital of 30,000*l.*, in 10*l.* shares, and was initiated in 1876 by an agreement to purchase Westfield House and grounds,—a residential estate most picturesquely situated within a mile of the town. During the past few years the town has unfortunately suffered from its evil reputation in a sanitary sense, the death-rate having reached the alarming figures of 28·00, 30·50, and 33·60 per thousand in the years 1873, 1874, and 1875 respectively. Last year, however, as the result of a Local Government Board inquiry, extensive alterations were effected in the flushing and ventilating arrangements of the sewers (constructed about thirteen years ago), and important additions were at the same time made to the sewerage system. It is hoped that these works, together with the greater amount of attention now devoted by the authorities to the removal of nuisances, and to sanitary matters generally, will result in greatly improved conditions, and render the town a a desirable place of resort, for which it is eminently adapted by the natural beauty and salubrity of its position. Mr. W. L. Newcombe, of Newcastle-on-Tyne, is the architect to the Company, and the contract for the necessary extensive additions to the buildings has been obtained by Messrs. Reed, of the same town. It is expected that the establishment will be ready for the reception of patients next season.

HORSES AND ASPHALTE.

SIR,—Can nothing be done to save our horses from the tortures and dangers they now endure through the asphalte pavement of our City streets? This pavement may be looked upon with favour by business men because of its noiselessness; but after twenty years' experience as a riding-master I consider it gross cruelty to horses, and positively dangerous to man, to ride or drive on pavement so paved, especially after a slight shower of rain. About a week ago, when returning from Rotton-row, where I had been riding with some of my pupils, I had to pass through King-street, Cheapside; a slight shower having fallen, I dismounted, and had my horses led; and although without burden of any sort, a sure-footed and very valuable animal, led with the greatest care by myself,

fell with such force that it has not yet recovered from the shock. It was the merest chance that a heavily-laden wagon did not pass over the forelegs of the animal, as the street was as slippery as glass. Had a rider been on its back a broken leg would have certainly been his fate.

I have written to the secretary of the Society for the Prevention of Cruelty to Animals, as it is high time they took the matter up. I am also forming a committee of my pupils and gentlemen who have suffered inconvenience from this pavement, so as to rid London of a nuisance too long meekly tolerated. If any of your readers will aid me in this good work, their cards will be highly esteemed by

F. A. EVANS.

DISSENTING CHURCH-BUILDING NEWS.

Northampton.—Gold-street Wesleyan Methodist Chapel, Northampton, is about to be improved and enlarged, at a cost of 1,200*l.*, from plans prepared by Mr. S. J. Newman, architect. The proposed alterations will include the repewing of the lower part of the chapel, enclosing the gallery stairs, altering the front of the gallery, erecting a new orchestra and rostrum, making new ceiling, and re-slating the roof, and the re-lighting and ventilating of the building.

Soho Hill, Birmingham.—On the 9th ult. the memorial-stone of a new Congregational chapel was laid at Soho Hill, Birmingham. The cost of the site was 2,965*l.*, and the contract price for the erection of the chapel and schools, and class-rooms in connexion therewith, is 10,973*l.* The architects are Messrs. Bidlake & Fleeming, of Wolverhampton, and the builders, Messrs. Horsman & Co., of the same town. Provision will be made to seat a congregation of 1,200 persons.

Brighton.—A new iron church, recently erected by the Wesleyan congregation in Brighton, upon the Preston-road, near the Viaduct, was opened on Tuesday. At the end of five years it is proposed to build a permanent chapel in the place of and upon the spot of the newly-opened iron structure. The church is covered with galvanised corrugated iron, the interior lining and pews being of varnished deal. It is estimated to accommodate about 310 persons. From end to end the building measures 70 ft., its breadth is 31 ft., and its height to the ridge of the roof about 23 ft. It has been built by Mr. W. F. Dennis, of London. The cost has been about 1,000*l.*

Books Received.

The Construction of Roads and Streets. By HENRY LAW, C.E., and D. K. CLARK, C.E. Illustrated. London: Crosby Lockwood & Co. 1877.

THIS work consists of two parts. The first is a treatise on the art of constructing common roads, written by Mr. Law, which has been revised and concluded by Mr. Clark, who has prefixed an historical sketch of the roads of England. It is a remarkable fact that while the island is scored from north to south, and from east to west, by the long straight lines traced by those great engineers, the Romans, the art of road-making is one that appears to have been almost entirely lost in this country after the termination of the four centuries of Roman rule. The same thing has occurred in other countries, notably in Syria, but has there been quietly attributed to the barbarism of the people. The viability,—to use a long word for lack of a short one,—of our turnpike-roads is chiefly due to the invention of Mr. Macadam. But the mode introduced by him, sixty years ago, of covering a rounded surface of earth with small broken stones, which are ground and compacted by the wheels of the vehicles into a hard uniform surface, has been in practice on the breccia roads of Italy time out of mind. The utter absence of good roads in England a century ago is a matter which would now be incredible, were it not so well attested.

It would have been well if Mr. Clark had collected a little information as to the introduction of the turnpike system, the length and cost of roads constructed under it, and the mode in which the later introduction of railways rendered the self-supporting system inefficient. As it is, his sketch is harldy to be called even a diagram of the history of our roads. In 1864 1,000 turnpike trusts existed in England, and 200 had been abolished. In 1821, as we learn from Sir John Rennie's life, 24,581 miles of turnpike road existed in England, and 8,000 in Ireland. In 1837 the debt on the turnpike trusts stood at 7,500,000*l.*, and the annual receipt from tolls was 1,509,985*l.* In 1869 the receipts had sunk to 934,233*l.*, and the expenditure was 929,340*l.* The length of turnpike roads existing in 1864, according to the report of the Local Government Board, was 20,636, to which has to be added 106,573 miles of highways. A work devoted to the subject of roads should give a *resumé* of these and similar facts. It should tell us what was the cost of road-making in the time of Telford, and give something of an engineering history of this essential element of civilisation. In this the work before us is sadly defective.

Mr. Law describes the laying out of a road, laying stress on the use of a map marked with contour lines, which, of course, reduces the task of the designer to a minimum, but for which the road-maker in India or Australia cannot be advised to wait. He speaks of the ordinary elements of construction, and gives a useful chapter, illustrated by tables and by formulæ, of the resistance to traction on common roads. This is followed by chapters on sections and inclines; on repairing and improving roads; on construction of roads, foundation and superstructure; on paved roads and streets; on hedges and fences; and on taking out quantities. There is a want of order and of system, as will be observed from the preceding list of chapters, in the work, but much valuable information is brought together in the pages.

In the second part of the volume Mr. D. K. Clark treats of the recent practice in the construction of roads and streets. The first chapter tells of the materials employed in such construction; and affords useful data for comparison between Macadam, asphalte, and wood. Three chapters are devoted to the first mode of covering; and the questions of cost, wear and tear, and resistance to traction, are fully illustrated. The cost of speed, when horse-power is employed, is remarkably shown from observations made by Mr. Farey. At two miles and a half per hour a horse will draw with a force of 100 lb., and the day's work will amount to 2,000 mile-pounds. At ten miles per hour the tractien is reduced to 28 lb., and the day's work to 420 mile-pounds. Another curious observation is taken from Sir John MacNeil, to the effect that 1 lb. of iron, in shoes, is worn away for sixty-three miles run by a horse, while 193 miles are run by a coach for the loss of 1 lb. worn from the tires. Comparing the weight of a horse with that of a coach the reverse might have been expected to occur. The observations show how much more destructive the hammering action of the horse's foot at a trot is than the rolling action of the wheel; and this gives light as to one of the sources of economy attainable by the introduction of steam as a locomotor power. Sir John MacNeil's proportions for the generality of roads are as follow:—

Cause of wear.	Fast coaches. Per cent.	Wagons. Per cent.
Atmospheric changes.....	20	20·0
Wheels	20	35·5
Feet of horses that draw the vehicles	60	44·5

The stone pavements of London, Liverpool, and Manchester, are described in considerable detail. Very much valuable information as to paving has been collected by the City Surveyor, Mr. Haywood, and has been fully employed by Mr. Clark. It may be useful to observe that the hardest and most durable stone is not so suitable for City paving as that of a somewhat softer nature. On the former the horses slip so constantly as to cause a serious interruption to the traffic. At the cost of a partial abrasion of the surface of the stone the greatest economy is secured all round. Mr. Clark says, "The hardest granites have invariably caused so much dissatisfaction that they have to be removed before they have been down many years. For instance, Penmaenmaur greywacke paving was laid in Newgate-street in 1851, and it was removed after a trial of two years and a half, as it was the cause of repeated complaints of slipperiness and noisiness. The Aberdeen blue granite sets have been for the most part employed in the construction of City pavements; they are considered to be the best, taking together the first cost, the durability, and the absence of slipperiness."

On the great question of the best pavement for London, as to which we gave consideration in No. 1,828 of the *Builder*, much useful detail will be found in Mr. Clark's book. It may be remembered that we found it hard to decide between the relative advantages of wood and of asphalte. The cost of the two is approximately the same. Safety, according to the observations of Mr. Haywood, is greater on wood,—the falls of horses being as 1·7 on asphalte to 1 no wood. To what was then remarked we wish to add the *per contra*, that the physiological test,—which is certainly the most important of all,—is in favour of asphalte. The perfect ease of running over the homogeneous surface is much less trying to the human nerves than is the succession of small blows given and sustained by the wheels on wood. In the increasing stress that is daily thrown upon the human system by the requirements of business, the question of quiet is perhaps the most important of all those that have to be considered with regard to the construction of roads.

A short chapter on stone tramways in streets is principally based on a "Report on Stone Tramways in Italy," by Mr. P. Le Neve Foster, jun., C.E. Some familarity with these roadways enable us to speak of them in very favourable language. Tramway is perhaps an improper term. The principle on which Turin and other Italian cities are, to a great extent, paved, is that of laying large blocks of smooth, well-jointed stone for the wheel-tracks, with pitched foot-ways for the horses between. For light rapid traffic this rigid roadway is disadvantageous, being destructive to the horses and to the vehicles,—throwing, in fact, the wear and tear off the road on to the moving stock. But for slow heavy traffic, and even for that mixture of heavy and of light traffic which is found in the commercial parts of London, nothing could be much better. Penmaenmaur stone, carefully dressed, might be found most admirably adapted for the wheel tracks; and if for the horse tracks the best wood paving were employed, we shou'd probably have a compound pavement that would unite the chief elements of durability, ease of traction, cleanliness, and safety in the most thorough manner. We should still hear the loud rumble of the wheels, but cannot expect to have everything we desire. We recommend all those who are interested in the subject,—and what Londoner is not?—to consult the information afforded by "The Construction of Roads and Streets."

It may be useful, in reference to that account of the turnpike roads and highways of England, which a book on the construction of roads ought to contain, to add some notes as to the roads of France, taken from the *Revue des Deux Mondes* for June 1st, 1878. The area of France, it will be remembered, is 204,100 square miles, or about half as much again as the area of the United Kingdom. "There exist at this moment," says the *Revue*, "on the French territory, about 38,000 kilomètres of national roads, 46,000 kilomètres of departmental roads, and 360,000 kilomètres of vicinal roads." It has been calculated, from official documents, that the stone annually required for the repairs of the national roads amounts to forty-five cubic mètres per kilomètre. The Reviewer deduces from this estimate that the stone required for the annual repair of all the roads of France would form a hill of two kilomètres and a half in circumference and 400 mètres high. According to figures given by Mr. Clark, the cost of maintaining 123½ miles of the suburban ways of the metropolis come to 534·5*l.* per mile, of which 238·6*l.* per mile was the price of granite and other hard stone. This figure, with an addition for flints and gravel, amounted to about 4d. per square yard, or 3s. 4d. per yard run of road. About forty cubic yards of granite, and 100 cubic yards of flint per mile, are the resulting quantities, the wear being 7½ in. deep over the whole surface of the roads in the year. This is seventy-five per cent. above the ratio of the French roads. But when it is remembered that in the one case we deal with suburban lines of way, and in the other with the national highways of a whole country, the comparison is favourable to the English road-maker.

We may add that the average cost of the maintenance of the turnpike roads, as they formerly were called, in England, in 1875, was 35*l.* 15s. 3d. per mile. In Wales, the cost was as low as 26*l.* 3s. 8d. per mile. As far as information has been collected, the ordinary road traffic has rather been diverted than destroyed by the introduction of railways. In France this is stated positively; the diminution of travelling on the truck lines, to which the railways run parallel, being fully made up by the increase of traffic on older lines. As far as the United Kingdom is concerned, the only information which we have seen referred to on this subject is based on the number of horses employed in subsidiary traffic, which is, we believe, considerably larger than that taken off from the

long lines. The re-establishment of the stage-coach, moreover, on certain favourite lines of road, during the summer, is a feature not to be lost sight of. Though our roads are superseded by our railways, for long distances, their importance to the country is rather increased than diminished by the enormous impulse given to our traffic,—and all that concerns their best and most economical construction and maintenance is of extreme value to the engineer.

Miscellanea.

The Old Workhouse, Lambeth.—At the weekly meeting of the Lambeth Board of Guardians, Mr. Hedley, one of the inspectors of the Local Government Board, attended for the purpose of addressing a few words to the Board with respect to the proposal to sell the old workhouse premises in Princes-road. He did not think, in making an application to that effect to the Local Government Board, the Board had fully realised the effect of their doing so, because he did not think the circumstances of the parish would justify such a proceeding. It was only that time last year they had in the workhouse 144 more persons than it was certified for, and now there were more in the house than there should be, whilst the place set apart for lunatics was wholly unsuitable. Nothing was more prejudicial to the proper administration of relief than for a parish to be short of workhouse accommodation, especially one like theirs, where they were spending 15,000*l.* a year in out-relief. A long conversation took place upon the subject, which the chairman closed by stating that when the guardians decided upon going to the enormous expense of building the new infirmary, they only did so after finding that the old building in Princes-road was quite incapable of improvement, and he therefore did not see what good they would now do by keeping such a building.

Manchester.—An institution for the adult deaf and dumb has been erected in Grosvenor-street, by Messrs. Robert Neill & Sons, at a cost of about 3,500*l.*, from the designs of Mr. J. Lowe, architect, Manchester, which were selected in competition. The principal elevation, fronting Grosvenor-street, is faced with Yorkshire stone, and is somewhat ornate. The building is designed in the Early English style, and internally is arranged in the basement as a gymnasium, and on the ground floors as a reading-room, coffee-room, secretary's office, class-room, and conveniences. The upper floor is devoted to a lecture-hall, with galleried floor. It is octagonal on plan, well lighted from the roof, and has a vestry and other requirements. The foundation-stone was laid by Mr. Hugh Birley, M.P., on June 2, 1877, and the building was opened on the 8th inst. by the Bishop of of Manchester.

One Way of Learning to Swim.—Lieut.-General J. E. Alexander, in view of the great numbers of lives recently lost through the inability of the unfortunate persons to swim, advocates the adoption of the following plan for teaching natation, which he says he has himself employed successfully. He says,—"Swimming may be taught in two days in this simple and inexpensive manner:—A pole 8 ft. or 10 ft. long is secured and projected from the stern of a boat; an iron ring at the end of the pole. A man rows the boat slowly in smooth water; another stands up in the boat and supports the learner by a girth round the chest, and a rope passed through the ring of the pole. He directs the learner how to make his strokes with his arms and legs (frog-like); supports him easily in the water, and gives him confidence. The third day he may dispense with the support."

Artisan Reporters for the Paris Exhibition.—At a meeting of the Birmingham Chamber of Commerce this week, the question of sending skilled artisan reporters to the Paris Exhibition, as advocated by the Prince of Wales in his letter to the joint Commission (published in the *Builder*, p. 415, *ante*), was discussed. Several manufacturers strongly supported the proposal, and offered subscriptions, after which, on the motion of Mr. J. S. Wright, seconded by Mr W. Wiggan, it was resolved,—"That a committee be formed to take into further consideration the expediency of sending artisan reporters to the Paris Exhibition, to confer with the Society of Arts thereon, and, if necessary, to call another meeting on the subject to take such other steps as they may deem necessary."

The Walter Press.—The *Daily News* of Saturday says:—"The great increase in our circulation having rendered the machinery,—seven Walter presses,—no longer adequate to produce the numbers required, an eighth Walter press, ordered a few weeks ago, has this week been erected in the machinery room of the offices in Bouverie-street, and was yesterday morning brought for the first time into use. The result, which is an extraordinary one, deserves mention in the history of machinery. Yesterday morning the eight presses, working simultaneously at the astonishing rate of 104,000 perfect copies per hour, accomplished the printing of no less than 120,000 copies of the *Daily News* in time for the departure of early newspaper trains.—*Times*.

New Cemetery, Darlington.—A memorial of the late Joseph Pease has recently been presented to the town in the form of a cemetery of fourteen acres, and the chapels and lodges in connexion therewith. Each member of the Town Council has received notice to inspect the buildings on the 19th inst. The Town Council, to mark their appreciation of this munificent gift, have erected, in a conspicuous part of the cemetery, a memorial of freestone and Sicilian marble, 23 ft. high. There are four panels in the base, and there is a suitable inscription on each. The shaft is formed by clustered columns, terminated by moulded caps, weatherings, and carved finial. The architect, both for the buildings and the memorial, is Mr. Geo. Gordon Hoskins, of Darlington.

Cleopatra's Needle.—The preparations for erecting the obelisk continue to progress. Two courses of the granite outside blocks of the base which will bear the monolith have been laid on three sides of the base, and the brickwork to fill the centre is being laid. Men are at work getting ready the scaffolding to enable the monument to be set up, and progress is being made in stripping the iron plates off the circular ribs of the *Cleopatra* ship. By permission of Mr. John Dixon, the Civil and Mechanical Engineers' Society will visit the works on Saturday next, the 22nd inst.

Robbing the Cambridge Slade Professor of Fine Art.—At the Marlborough-street Police-court, on Wednesday, William West, cabman, and Matthew Murphy, described as a horsekeeper, were charged on remand with being concerned in stealing a portfolio, containing engravings of the value of 1,500*l.*, and a black bag, the property of Professor Sidney Colvin, of Trinity College, Cambridge. The robbery took place from a cab which had been engaged to convey the Professor from the Savile Club. The magistrate expressed his intention of committing the prisoners for trial.

Ropemakers' "Fields," Limehouse.—At the last meeting of the Limehouse District Board of Works, with respect to a reference from the Board as to the condition of some houses in one of the courts in Ropemakers' Fields, Limehouse, Dr. Rogers reported that, after inspection, he had taken proceedings at the Thames Police-court, the result of which was that an order had been obtained from the magistrate to close the houses forthwith, and until they were repaired to the satisfaction of the Board.

Proposed New Laundry at Paddington Workhouse.—At the last meeting of the Paddington Board of Guardians, a report from the Workhouse Structural Arrangement Committee, recommending the construction of a new laundry, and that Mr. H. H. Collins, the architect, be engaged to prepare plans and specifications for the new building, was adopted.

The Society of Engineers will, on Monday next, visit Messrs. Doulton's potteries at Lambeth, afterwards proceeding to the well-known engineering workshops of Messrs. Maudslay, Sons, & Field, and thence to the Blackfriars Goods Station of the London, Chatham, and Dover Railway, to see the hydraulic machinery.

Want of Work.—There were 121 applicants, according to the *Sanitary Record*, for the office of Surveyor to the Corporation and Urban Sanitary Authority of Leamington, at 300*l.* per annum. How many of them, we wonder, could discharge properly the duties of the office?

The District Surveyors' Association.—The members of this important association dined together, as of old time, at the Albion, in Aldersgate-street, on Wednesday evening last. Mr. Edmund Woodthorpe presided genially, and some pleasant speeches were made.

New Esplanade, St. Leonard's-on-Sea.—A new esplanade, about 2,000 ft. in length, was formally opened on Wednesday at St. Leonard's-on-Sea. The work extends the parade at Hastings and St. Leonard's to about three miles. A luncheon was given by the Rev. J. Alton Hatchard in celebration of the occasion.

The Architectural Association's Annual Dinner will, as announced by advertisement, take place on Tuesday evening next.

TENDERS

For schools, teachers' house, boundary walls and fences, and asphalte play-grounds, at Sutton Bridge, for the Long Sutton School Board:—

Girling & Son	£1,820 0 0
Goodman & Ream	1,770 10 0
Dawson	1,567 0 0
Allister	1,549 0 0
Waterman & Bateman	1,543 0 0

For rebuilding No. 11, James-street, Cannon-street, for Mr. Stark:—

Holist	£800 0 0
Palmer	675 0 0
Moyle & Son (accepted)	674 0 0

For four houses, Green-lane, St. Helen's. Mr. James Rimmer, architect. Quantities supplied:—

Belsher	£2,198 0 0
Harris & Sons	1,990 0 0
Barton	1,990 0 0
Harrison	1,989 0 0
Whittaker & Forster (accepted)	1,985 0 0

For additions to Fortescue House, Twickenham, for Mr. W. Williams, and the committee. Mr. E. P. Loftus Brock, architect:—

Downs	£1,825 0 0
Nye	1,680 0 0
Messom	1,546 0 0
Brass	1,440 5 6
Ennor, Julian, & Co.	1,350 0 0
Matlock	1,087 0 0
Haynes (accepted)	1,078 16 6

For rebuilding No. 45, Gerrard-street, Soho. Mr. C. F. Hayward, architect:—

Langmead & Way (accepted).

For alterations at the Dolphin, Tonbridge-street, Euston-road, for Mr. J. Ayars. Mr. J. R. Furniss, architect:—

Hatcham	£142 0 0
Kent	108 0 0
Schlater	72 10 0

For building coachhouses and stables at the rear of Crogsland-road, Chalk Farm-road, for Mr. George John Smith. Mr. James R. Furniss, architect:—

Toms	£965 0 0
Rowe	912 0 0
Durnford	847 0 0
Steed	864 0 0
White (accepted)	697 0 0
Scrivener	696 0 0

For additions to Dynmore, Watford, Herts, for Mr. H. S Sherry. Mr. C. A. Legg, architect:—

Allen	£728 0 0
Chadwick	634 0 0
Waterman	599 0 0
Turner	595 0 0

For New Marine Hotel, Hythe, Kent, for the South Eastern Railway Company. Mr. F. W. Porter, architect. Messrs. Williams & Gritten, surveyors:—

A.—*For Concrete Works only.*

Langmead & Way	£6,486 0 0
Naylor	5,990 0 0
Drake	5,935 0 0
Belham & Co.	5,934 0 0
Higgs & Hill	5,499 0 0
Adcock	5,204 0 0
Slade	5,196 0 0
Prebble	5,069 0 0
Perry & Co.	5,000 0 0
Clemmins	4,539 0 0
Braid & Co.	4,368 0 0
Fowler	4,312 0 0

B.—*For all other Trades.*

Prebble	£26,000 0 0
Slade	24,749 0 0
Belham & Co.	22,886 0 0
Naylor	21,890 0 0
Perry & Co.	20,790 0 0
Higgs & Hill	20,494 0 0
Adcock	20,262 0 0
Fowler	20,032 0 0
Clemmins	19,692 0 0
Langmead & Way	19,349 0 0
Braid & Co.	18,630 0 0

For dwelling-house, &c., to finish, Harefield-road, Uxbridge. Mr. Godbolt, surveyor:—

Salmson	£2,600 0 0
Hunt	2,486 6 6
Cave	1,953 5 6

For building seven cottages at Mortlake, for Mr. H. Ashman. Messrs. Tress & Innes, architects:—

Tozer (accepted)	£1,150 0 0

For alterations and additions to No. 63, Bridge-street, Swindon. Mr. W. H. Read, architect:—

Webb (accepted)	£291 0 0